LONDON COUNTY COUNCIL

The Distribution and Relations of Educational Abilities.

Report by the Education Officer submitting Three Preliminary Memoranda by Mr. CYRIL BURT, M.A., Psychologist to the Council, on the Distribution and Relations of Educational Abilities - -

R. BLAIR,
Education Officer.

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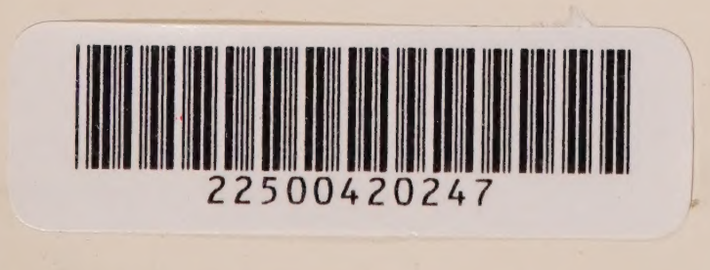

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LONDON COUNTY COUNCIL

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Although these memoranda are published by the Council, it must be understood that responsibility for the views and conclusions therein expressed rests with the writers alone.

PREFATORY MEMORANDUM BY THE EDUCATION OFFICER.

Arising out of his immediate duties in connection with special (M.D.) schools and following on some previous inquiries, the results of which have already been published by the Council, Mr. Burt has pursued his investigations into the distribution of educational ability among the whole of the children in the special (M.D.) schools and in the ordinary elementary schools within a representative borough.

It is obvious, from a mere turnover of the pages, that the memoranda have involved most extensive, arduous and painstaking work; a study of them has proved of the greatest interest and has convinced me of their wide and immediate usefulness to the practical teacher. The three memoranda indeed make a unique contribution to the scientific study of educational problems. To the best of my knowledge this volume is the first of its kind in Europe or elsewhere. Its basis is the London schools, and to that extent the value of many of its results is local, but its methods are universal and cannot but raise large issues in schools otherwise organised and among students of education in Europe and America.

Only a very few can, and only a very few need, carry out researches so extensive, and extract with such exhaustive care and fertile resource generalisations of such wide importance and usefulness from such a mass of complicated details. It is most gratifying to learn that Mr. Burt found the teachers in the representative borough most willing to assist in his interesting though exhaustive task.

The memoranda offer some stiff reading. It may be expected that only the ablest teachers will master the details of methods and results; but there should be no teacher in the London service for whom the memoranda do not throw a flood of new light on old problems even on a first reading. The memoranda will no doubt stimulate a large number to repeat the inquiries, and they should certainly induce all to test the results, so far as this is possible within the limits of their own schools.

Mr. Burt warns his readers continuously that his investigation has reached only a first approximation; an extensive application of his results and their consequent criticism should bring a continued enquiry to a closer approximation of the truth.

His first concern was the line which should mark off the special (M.D.) child from the normal or ordinary elementary school child. His investigations next led him into a study of the average attainments at each age of the normal children and the limits of deviation above or below that average. He then carries his readers through a long but deeply interesting study of backwardness and special aptitudes.

After many hours spent on Mr. Burt's three memoranda I have been deeply impressed both by his methods and results. He has shown, by extensive inquiry, ingenuity and resourcefulness, how the principles and processes underlying the commonest school facts and operations can be revealed; and has initiated a group of investigations which, if continued extensively and intensively, should lift the practice of teaching from empiricism and lay it on a broad scientific foundation.

Every teacher who, even at a considerable distance, follows the spirit and conclusions of these investigations by so much helps to establish the claim that his profession is a learned one. Were the majority of teachers operating in the same spirit, a great impetus would be given to educational research which would result in lasting benefit to the schools.

The survey shows that in education there is a vast field for practical research. "When the present crisis is over," writes Mr. Burt, "the nation will stand confronted with the task of social reconstruction. In preparation for this general overhauling one urgent item is the research for which I have appealed. To take the place of the ability that has been lost to the community, we have to discover the best methods of detecting fresh supplies of ability and the best means of training and utilising it to the utmost of which it is capable. Scientific research in education is thus needed not only to enhance the practice and profession of teaching, but also to promote the welfare of the nation in the near future."

Several times Mr. Burt has insisted that his suggestions and conclusions are tentative and provisional. Even so, many of them are of immediate practical value for those engaged in educational administration and particularly for the teachers in the schools, for example, in testing the value of their own classification. After much hesitation I have endeavoured to re-state some of his conclusions in a different order. I am fully conscious that in removing such conclusions from their context I have inevitably given them much baldness; and that in using as far as possible the less technical language to be found frequently in the body of the memoranda, I have lost much in precision. I hope, however, that in gathering the main conclusions together from the body of the text I have done something to assist those who will be unable

to find time for an exhaustive study of memoranda which occasionally demand severe efforts on the part of their readers.

I.—EDUCATIONAL ABILITIES.

Achievements in the subjects of the school curriculum appear to be determined by mental factors of two kinds:—

1.—*General educational ability:* a common factor entering into all school work. This common factor is not a simple but a complex capacity, partly dependent on a still more general intellectual factor, "general intelligence" (all-round mental efficiency) and partly including other important factors such as long-distance memory, interest and industry. General educational ability determines performances in different school subjects in different degrees: such subjects as composition and perhaps problem work in arithmetic are intimately dependent on it, and, if suitably tested and marked, perhaps form the best measures of it.

2.—*Specific educational abilities:* special aptitudes confined to special subjects and groups of subjects. These apparently depend upon psychological factors, largely innate, but partly on moral factors determined by interest in the subject, the culture of the home, and the personality of the teacher.

Allowing for the influence of general educational ability, school subjects fall into four main groups, apparently dependent upon four specific abilities, complex, and nearly, though not entirely, independent:—

(1) *Arithmetical.*
(2) *Manual.*
(3) *Linguistic.*
(4) *Literary.*

The specific abilities to some extent overlap. (*See* the "Ring" diagram, page 59.) "It is tempting to infer," says Mr. Burt, "that the ordinary school curriculum views scholastic ability from almost every side." It is equally tempting to suggest that the ring predicts that there are gaps to be filled in between the Linguistic and Literary group and the Manual group on the one hand, and the Arithmetical group on the other.

II.—NORMAL AND BACKWARD CHILDREN.

1.—On an average the normal child advances very nearly one standard in each successive year. The correlation between age and class, in the case of the normal child, is high but imperfect and may be roughly stated thus:—

$$\text{Age} = \text{Standard} + 6.$$
$$\text{Standard} = \text{Age} - 6.$$

2.—In educational ability normal children tend on an average to vary above and below the mean level for their age as follows:—

at the age of 5 by just half a year;
at the age of 10 by at least one year;
at the age of 15, in all probability, by nearly one and a half years;
and throughout by *about one-tenth of their age.*

Roughly speaking, these limits correspond with what in the Memoranda is termed the Standard Deviation.

3.—For practical purposes "backward" may be taken to denote children who, though not "defective," are yet unable in the middle of their school career to do the work even of the class below their age and are retarded by about 15 to 30 per cent. of their age. In this sense the total number of backward children in the senior department of the borough investigated may be assessed at 10 per cent. at the very lowest estimate. In the whole county the number of backward children between 8 and 14 is estimated as being at least from thirty to fifty thousand. Mr. Burt has thus put an approximate measure (say 40,000) on a well-known problem. Efforts to deal with backward children, as distinct from defective, are still in their infancy, and are the result of the initiative of individual head teachers and inspectors rather than of any collective or central administrative act.

The tentative suggestions as to the causes and treatment of backwardness are fully set out on pages 36–40, and should be read *in extenso.*

III.—MENTALLY DEFICIENT CHILDREN.

Children in special (M.D.) schools are characterised more by backwardness in school work than by defective intelligence. Defective intelligence is usually accompanied by extremely defective attainments; but defective attainments are by no means an invariable index of an equal defect in intelligence (*see* pp. 16 and 17, particularly the paragraph at the top of p. 17). Children in special (M.D.) schools often prove in the first instance to be school failures, and not always mental defectives in the narrower sense. The provisional diagnosis of educational backwardness and mental deficiency should be based primarily upon the child's performances with educational and mental tests.

1.—The educational development of defectives is about twice as slow as that of normals, viz., about half a grade or standard per annum: in other words, the educational attainments of a "defective" correspond, on an average to those of a "normal" just over half his age. We have thus a simple rule for predicting the most probable degree of educational deficiency for any special school child of any given age. With defectives educational develop-

ment is not only slower: it also seems to slacken and cease towards the end of the school career. Many, doubtless, arrive prematurely at the limit of their mental growth.

2.—On an average, the deviation of the defectives from the normal level is about four and a half times the "standard deviation" of the "normals." It is always in a negative direction, that is, towards a lower educational grade.

3.—No child who has three-quarters or more of the educational attainments proper to his age should be even considered as a potential candidate for admission to an M.D. school. In the case of candidates who are retarded by less than 31 per cent. of their age and therefore have over two-thirds of the normal attainments, evidence of deficiency in general intelligence or of emotional instability should also be required. Even for all who have more than half the normal attainments it is desirable to have such evidence; and this may often call for prolonged observation in a sorting class or clearing school.

The upper limits (in grades and standards) for candidates nominated for the statutory examination for admission to a special (M.D.) school are set out in Table XVI, p. 44.

With these limits the special school accommodation provided for defectives in London appears to be sufficient: were the backward children accommodated in special classes or in special schools of lower grade, the accommodation would be more than sufficient.

IV.—CANDIDATES FOR CENTRAL SCHOOLS AND JUNIOR COUNTY SCHOLARSHIPS.

Potential candidates for central schools should be advanced above the average by about 15 per cent. of their age and potential junior county scholarship children by about 25 per cent.

V.—GENERAL.

1.—Of children remaining in the ordinary elementary school after transfer of Central School and Scholarship children, some perhaps have not had an opportunity of developing their superior talent. This view corresponds with the more popular view that there is too much marking time in the top classes.

2.—Between Council and Non-provided schools the differences in retardation are consistent and marked. In Council schools there are 43·5 per cent. below the level of their age. In Non-provided schools there are 50·3 per cent., practically one-half. The discrepancy is greatest in the case of the girls. In their case the figures are 41·6 per cent. (Council schools) and 53·7 per cent. for Non-provided schools. Here is a fruitful subject of inquiry for inspectors and head teachers.

3.—The investigation seems to confirm the hypothesis that mental abilities are distributed among the population according to the law of averages, *i.e.*, they may, if a sufficiently wide field is taken, be arranged approximately according to the normal curve in the same way as distributions of height and weight.

If this position is established, important criteria will be available for guiding local authorities in such matters as the amount of special school accommodation to be provided and the number of scholarships to be awarded.

4.—The differences between individuals tend to grow larger as the individuals themselves grow older. This view is again in accordance with the popular view and forms the sanction behind smaller classes at the top of the ordinary elementary school, and in central and secondary schools. The corollary to this conclusion—the increased differentiation manifested at higher ages—demands a corresponding increase of differentiation in the education thus provided: it also offers matters for much practical consideration. Mr. Burt has put the same view differently in the statement: children classed together as infants may be unable to associate for joint work when nearly adult. The view harmonises with the experience of teachers, but it is a good thing to have it put so tersely.

5.—The main effect of teaching on educational ability is, as a rule, to increase the individual differences already present from birth.

6.—If the child population and the community at large have profited by the establishment of special schools and classes for the educationally incompetent, much more would they profit by refining the procedures for discovering and training those who are the most efficient for their age. Here, therefore, says Mr. Burt, lies a valuable field for future surveys and future research, and, let me add, for administrative action.

7.—In a provisional survey of the results of an analysis of the psychological nature of scholastic abilities Mr. Burt suggests the following conclusions:—

(i.) The abilities and processes involved are far more complex than those who have written upon this subject commonly assume.

(ii.) Similar results are reached by different children by very different mental processes; consequently a child who fails under one method of instruction will often succeed, if a brief study be made of his natural aptitudes and operations, and another mode of instruction adopted accordingly.

(iii.) Similar subjects require very different abilities at different ages, and at different stages of progress.

8.—The psychographs for special educational abilities reproduced between pp. 64 and 65 are most interesting, and suggest great possibilities for the inquiring teacher.

In Composition, Reading and Arithmetic schools or groups drawn from the poorest homes may be nine to twelve months or more behind those drawn from the best: they differ little, if at all, in manual subjects.

The sections on the overlapping of age-groups, on the distribution of age in school classes, and on the overlapping of classes (pp. 70–74) deserve to be read and re-read again and again by all teachers. Mr. Burt points out that the most obvious reform would be (so far as administrative considerations permit) to reclassify for different subjects or groups of subjects. This reform, as is well known, is exacting much thought in secondary schools, but it has not become a practical issue in elementary schools, in which it should not be forgotten Mr. Burt's investigations have lain and for which his conclusions have been drawn.

In Appendix II. will be found an ideal classification of children according to educational ability at each age.

R. Blair.

L.C.C. Education Offices,
Victoria Embankment, W.C.
16th February, 1917.

INTRODUCTORY NOTE.

Aim of the Investigation.

The chief object of these memoranda is to present a preliminary estimate of the distribution of educational abilities among children of ordinary elementary schools and of special schools for the mentally defective. The enquiry is for the most part a by-product of other work; and can therefore claim to reach only a first approximation. As is inevitable in an initial attempt, the methods are but tentative; the results, provisional.

There are few problems in educational organisation which do not involve some assumption, either tacit or express, as to the way in which educational ability is distributed. The most efficient method of organising school classes; the subjects for which cross-classification is needed; the best schemes of promotion; the proper allotment of marks; the procedure in internal examinations and in examinations for scholarships; the standards of achievement, optimal as well as minimal, attainable under different conditions and at crucial stages in the school career; tests of progress or deterioration in the educational system as a whole and in individual schools and children; the provision needed for children in special categories—"backward," "defective," "unstable," "advanced," or "talented"; the allocation of individuals of appropriate ability to appropriate vocations—these and numerous other problems would be largely solved by a Scientific Census of Educational Abilities, uniformly carried out and periodically repeated. The present survey is a preliminary attempt to discover within a limited area how far such a census may eventually be practicable.

Educational Census of a Single Representative Borough.

With this object ultimately in view, I have endeavoured in the course of my work to make a survey of the educational abilities of the entire elementary school population of a single representative borough. The immediate purpose of the survey has been three-fold: (1) to discover both the actual and the most suitable lines of demarcation between children in the ordinary schools and children admitted to special schools for the mentally defective; (2) to obtain some estimate of the number of backward children in the ordinary schools; and, finally, (3) to verify the hypothesis of a

"general educational ability" underlying work at all school subjects, and to estimate the reliability of current methods of marking and classifying children according to the degree in which they exhibit that ability. The first problem bears most directly upon my chief duties; and has therefore been considered first. The second, on account of its size, has been attempted by but rough methods. The third problem is theoretical and subordinate. It has been studied only upon a very limited scale; and considered last. Thus, what might seem the natural order of study and presentation, from a logical standpoint, has for practical reasons been inverted.

The borough chosen for the purpose of this survey was one of the largest of the metropolitan boroughs in the north of London. Before finally deciding upon this choice, the social conditions were reviewed from published data—the current volume of *London Statistics*, Charles Booth's *Life and Labour of London*, Mudie-Smith's *Religious Life of London*, and similar publications; and then studied concretely from information gleaned from care committee visitors, attendance officers, and similar sources, and, above all, from residence in one of the settlements situated in the district. The social statistics for this borough seem in most respects to deviate but little from average figures for London generally. Representatives of nearly every social class appear to be contained within it: whereas boroughs lying further west contain an unusual proportion of the wealthier classes; boroughs lying further east contain increasing proportions of the lower and lowest classes; and the smaller boroughs adjoining the city and the larger boroughs in the south have peculiar characteristics of their own. At the same time, there is in this locality a number, perhaps somewhat large, suffering markedly from an unfavourable economic or moral environment, from defects of health or physique, and from mental and moral deficiencies presumably innate. It may, therefore, be fairly expected that the borough chosen will exhibit a representative proportion of children of average educational ability, together with typical samples of both able and inefficient pupils, sufficiently numerous for independent analysis.

Extensive and Intensive Methods of Investigation.

The investigation has mainly followed two lines of approach. First, an extensive survey has been made for general educational ability. This has embraced all the children upon the roll of ordinary and special (M.D.) schools, and has been based upon returns and estimates furnished by head teachers. Secondly, an intensive examination has been made of particular children and particular schools, including all the special (M.D.) schools, by the method of mental and scholastic tests. This has been done both to check the criteria employed by the teachers, and to examine the relation of proficiency in particular subjects to educational ability in general.

To analyse the results the methods adopted have been unavoidably elaborate and technical. Subsequent enquiries may prove them perhaps needlessly intricate, perhaps insufficiently exact. In a pioneer enquiry, however, methods are always of greater interest than results. For purposes of reference and repetition, therefore, they have, in the body of the memoranda, been described in full; though psychological and statistical technicalities have, where possible, been simplified or removed. Those interested merely in the final conclusions will turn first to the summary at the end (pp. 80 to 84) and refer only to the leading tables and diagrams there cited.[1]

CYRIL BURT.

30th December, 1916.

(1) I should like to express my gratitude to Mr. G. Udny Yule for reading the greater part of these memoranda in typoscript, to Professor J. A. Green and to Dr. C. Barrow Burt for reading them in proof, and to Dr. C. W. Kimmins for reading both proof and typoscript. To their several criticisms and suggestions I am much indebted. I am also greatly indebted to Miss V. G. Pelling for much assistance both in making and in checking calculations. In seeing the Memoranda through the press the advice and assistance of Mr. A. W. Phillips have been invaluable. Above all I must acknowledge my great indebtedness to numerous head and assistant teachers, who have so readily helped me by compiling lists, schedules and estimates, or have arranged for me to carry out experiments and tests upon the children in their charge.

Three Preliminary Memoranda on the Distribution and Relations of Educational Abilities.

MEMORANDUM I.

DISTRIBUTION OF EDUCATIONAL ABILITY AMONG CHILDREN IN *SPECIAL (M.D.) SCHOOLS.*

Estimates of General Educational Ability.

In the course of the past year, I have visited all the special (M.D.) schools in the borough selected for this survey, and have obtained an estimate of the educational ability of every child upon the roll.

The estimate was intended to provide a single measure of the average ability of each child in all the chief subjects of the school curriculum. The conception of General Educational Ability as a single capacity will be justified by detailed evidence in a later memorandum.[1] Among normal children, a child who is good at one subject is the more likely to be good also at another: with them, ability in all subjects appears to be determined largely by one common or general factor. Among children in special schools, this general tendency is far less marked: a conspicuous deficiency in reading or arithmetic, for instance, accompanied by a normal or nearly normal ability in all other subjects, is with them by no means rare. Accordingly, for the defective children, especially for those of a higher grade, the estimates had commonly to be drawn up separately for reading, arithmetic and handwork, and the final grading to be formed by amalgamating the three.

"Grades" and "Standards" as a Scale of Mental Measurement.

The estimates of ability were based chiefly upon the children's attainments. They were supplied by the head teacher, acting usually in consultation with the class teacher and myself; and were checked by standardised tests.

The estimates were either obtained in, or else reduced to, terms of "grades" and "standards." The degrees of attainment signified by the several "standards" were taken as defined by the earlier Board of Education codes. Among normal children (as will presently be shown, and as indeed is generally recognised), each grade or standard corresponds approximately to a definite school year. Provisional "norms" for each school year or class have been prepared in terms of scholastic tests; and, after further experiments, will be published in full. For purposes of mental

(1) See *Memorandum* III., pp. 53-55.

measurement, the whole series of grades and standards may be very conveniently treated as forming a continuous scale. The scale will range from a theoretical St. −3 (corresponding to grade 0 and age 3), through St. 0 (corresponding to grade iii. and age 6), and St. 1 (corresponding to age 7), up to St. 8 (corresponding to standard Ex.-VII. and age 14), and a theoretical St. 9 for all above Ex.-VII. The class intervals will be treated as divisible into fractions. Thus, "Standard I." is taken as covering a range from St. 1·0... to St. 1·99..., with a mid-value at St. 1·5..., just as "age 7-" is used to mean "over 7·0 years and under 8·0 years," with a mid-value at $7\frac{6}{12}$ years. The need for this is clear. It is often necessary to discriminate finer shades of ability than the crude class intervals. Teachers, for example, will give such assessments as "a good St. II." or "St. I. plus," or "Grade iii. B"; and again "St. I. for arithmetic" has to be averaged with "St. II. for reading." In these cases, the original values can be converted into quantitative form, and manipulated algebraically, only by means of a continuous fractional scale. Such a scale then, is eminently suitable for theoretical and statistical purposes. At the same time, the unit of measurement remains closely related to practical experience; and possesses a familiar, concrete significance which a novel scale, devised *ad hoc*, would no longer convey.

Mental and Scholastic Tests.

In addition to securing estimates, I have also personally carried out tests. By this means I have endeavoured to ensure that the standards of comparison adopted in the different schools, whether special or ordinary, shall be approximately the same. All the children in the special (M.D.) schools of the borough have been examined either individually or in class. The class-tests employed were simple exercises in Number, Dictation and Drawing: for Reading and Intelligence, individual tests were also made with particular children. The results of the Intelligence tests have already been in part presented in reports on particular schools. The present memoranda are concerned with educational capacities alone.

Results.

There are in all the special (M.D.) schools nearly 600 children. Between the ages of eight and fourteen there are in each age-group from 50 to 100 children. The results, therefore, are sufficient in number to yield a working conception of the distribution of educational ability in London special schools.

Age-and-Grade Tables.

Table I. shows the distribution of educational ability, by age and grade, among the children upon the roll of the six special (M.D.) schools in the borough. For brief reference it will be convenient to describe such tables as Age-and-Grade Tables. It presents the original data upon which the present memorandum is based.

The total figures for all six schools are given in Table II.

The general distribution of educational ability in the special (M.D.) schools of the borough is shown diagrammatically in Figure 1. The base-line represents the scale of grades and standards: the vertical columns represent by their height the number assigned to each standard or grade.

Table III. gives the percentage of those upon the roll who are assigned to the several grades and standards in each school and in all the schools taken together.

TABLE I.—DISTRIBUTION OF EDUCATIONAL ABILITY— SPECIAL (M.D.) SCHOOLS.

Table showing numbers of children at each age in each school attaining the grade or standard indicated.

	Age.	Grade 0.	Grade i.	Grade ii.	Grade iii.	Standard I.	Standard II.	Total for each age.
School No. 1.	7 -	2	2	1	—	—	—	5
	8 -	3	7	2	—	—	—	12
	9 -	2	9	8	2	1	—	22
	10 -	—	4	15	5	3	—	27
	11 -	—	3	4	5	—	—	12
	12 -	—	1	4	6	—	—	11
	13 -	—	—	—	3	—	—	3
	14 -	—	—	—	1	—	—	1
	15 -	—	—	—	1	1	—	2
Total for each grade or standard		7	26	34	23	5	—	95
School No. 2.	7 -	2	3	—	—	—	—	5
	8 -	2	3	—	—	—	—	5
	9 -	—	6	7	1	—	—	14
	10 -	—	4	11	4	2	—	21
	11 -	—	2	8	7	3	—	20
	12 -	—	—	3	5	1	—	9
	13 -	—	—	5	4	4	—	13
	14 -	—	—	5	—	2	—	7
	15 -	—	1	—	—	—	—	1
Total for each grade or standard		4	19	39	21	12	—	95
School No. 3.	8 -	3	3	—	—	—	—	6
	9 -	2	3	—	1	—	—	6
	10 -	2	4	2	4	1	—	13
	11 -	—	4	6	7	2	—	19
	12 -	—	2	1	2	3	—	8
	13 -	—	3	3	—	1	1	8
	14 -	—	—	2	1	—	1	4
	15 -	—	—	—	1	—	—	1
Total for each grade or standard		7	19	14	16	7	2	65
School No. 4.	7 -	—	1	2	—	—	—	3
	8 -	1	1	2	—	—	—	4
	9 -	—	1	5	4	1	—	11
	10 -	—	—	3	9	1	—	13
	11 -	—	—	—	3	7	1	11
	12 -	—	—	—	3	3	2	8
	13 -	—	—	—	1	—	—	1
	14 -	—	—	—	—	—	—	—
	15 -	—	—	—	—	1	—	1
Total for each grade or standard		1	3	12	20	13	3	52
School No. 5.	6 -	—	—	1	—	—	—	
	7 -	2	3	—	—	—	—	
	8 -	1	4	7	2	—	—	14
	9 -	1	6	1	10	—	—	18
	10 -	—	2	10	17	7	—	36
	11 -	—	1	5	20	8	—	34
	12 -	—	—	3	10	4	—	17
	13 -	—	—	—	12	1	—	13
	14 -	—	—	—	3	1	—	4
	15 -	—	—	3	6	1	—	10
Total for each grade or standard		4	16	30	80	22	—	152
School No. 6 (Elder boys).	11 -	—	—	1	4	5	—	10
	12 -	—	—	1	8	25	3	37
	13 -	—	—	1	13	12	19	45
	14 -	—	—	1	13	6	16	36
	15 -	—	—	3	3	2	—	8
	16 -	—	—	—	1	—	—	1
Total for each grade or standard		—	—	7	42	50	38	137

measurement, the whole series of grades and standards may be very conveniently treated as forming a continuous scale. The scale will range from a theoretical St. −3 (corresponding to grade 0 and age 3), through St. 0 (corresponding to grade iii. and age 6), and St. 1 (corresponding to age 7), up to St. 8 (corresponding to standard Ex.-VII. and age 14), and a theoretical St. 9 for all above Ex.-VII. The class intervals will be treated as divisible into fractions. Thus, " Standard I." is taken as covering a range from St. 1·0... to St. 1·99..., with a mid-value at St. 1·5..., just as " age 7- " is used to mean " over 7·0 years and under 8·0 years," with a mid-value at $7\frac{6}{12}$ years. The need for this is clear. It is often necessary to discriminate finer shades of ability than the crude class intervals. Teachers, for example, will give such assessments as " a good St. II." or " St. I. plus," or " Grade iii. B "; and again " St. I. for arithmetic " has to be averaged with " St. II. for reading." In these cases, the original values can be converted into quantitative form, and manipulated algebraically, only by means of a continuous fractional scale. Such a scale then, is eminently suitable for theoretical and statistical purposes. At the same time, the unit of measurement remains closely related to practical experience; and possesses a familiar, concrete significance which a novel scale, devised *ad hoc*, would no longer convey.

Mental and Scholastic Tests.

In addition to securing estimates, I have also personally carried out tests. By this means I have endeavoured to ensure that the standards of comparison adopted in the different schools, whether special or ordinary, shall be approximately the same. All the children in the special (M.D.) schools of the borough have been examined either individually or in class. The class-tests employed were simple exercises in Number, Dictation and Drawing: for Reading and Intelligence, individual tests were also made with particular children. The results of the Intelligence tests have already been in part presented in reports on particular schools. The present memoranda are concerned with educational capacities alone.

Results.

There are in all the special (M.D.) schools nearly 600 children. Between the ages of eight and fourteen there are in each age-group from 50 to 100 children. The results, therefore, are sufficient in number to yield a working conception of the distribution of educational ability in London special schools.

Age-and-Grade Tables.

Table I. shows the distribution of educational ability, by age and grade, among the children upon the roll of the six special (M.D.) schools in the borough. For brief reference it will be convenient to describe such tables as Age-and-Grade Tables. It presents the original data upon which the present memorandum is based.

The total figures for all six schools are given in Table II.

The general distribution of educational ability in the special (M.D.) schools of the borough is shown diagrammatically in Figure 1. The base-line represents the scale of grades and standards: the vertical columns represent by their height the number assigned to each standard or grade.

Table III. gives the percentage of those upon the roll who are assigned to the several grades and standards in each school and in all the schools taken together.

TABLE I.—DISTRIBUTION OF EDUCATIONAL ABILITY— SPECIAL (M.D.) SCHOOLS.

Table showing numbers of children at each age in each school attaining the grade or standard indicated.

	Age.	Grade 0.	Grade i.	Grade ii.	Grade iii.	Standard I.	Standard II.	Total for each age.
School No. 1.	7–	2	2	1	—	—	—	5
	8–	3	7	2	—	—	—	12
	9–	2	9	8	2	1	—	22
	10–	—	4	15	5	3	—	27
	11–	—	3	4	5	—	—	12
	12–	—	1	4	6	—	—	11
	13–	—	—	—	3	—	—	3
	14–	—	—	—	1	—	—	1
	15–	—	—	—	1	1	—	2
Total for each grade or standard		7	26	34	23	5	—	95
School No. 2.	7–	2	3	—	—	—	—	5
	8–	2	3	—	—	—	—	5
	9–	—	6	7	1	—	—	14
	10–	—	4	11	4	2	—	21
	11–	—	2	8	7	3	—	20
	12–	—	—	3	5	1	—	9
	13–	—	—	5	4	4	—	13
	14–	—	—	5	—	2	—	7
	15–	—	1	—	—	—	—	1
Total for each grade or standard		4	19	39	21	12	—	95
School No. 3.	8–	3	3	—	—	—	—	6
	9–	2	3	—	1	—	—	6
	10–	2	4	2	4	1	—	13
	11–	—	4	6	7	2	—	19
	12–	—	2	1	2	3	—	8
	13–	—	3	3	—	1	1	8
	14–	—	—	2	1	—	1	4
	15–	—	—	—	1	—	—	1
Total for each grade or standard		7	19	14	16	7	2	65
School No. 4.	7–	—	1	2	—	—	—	3
	8–	1	1	2	—	—	—	4
	9–	—	1	5	4	1	—	11
	10–	—	—	3	9	1	—	13
	11–	—	—	—	3	7	1	11
	12–	—	—	—	3	3	2	8
	13–	—	—	—	1	—	—	1
	14–	—	—	—	—	—	—	—
	15–	—	—	—	—	1	—	1
Total for each grade or standard		1	3	12	20	13	3	52
School No. 5.	6–	—	—	1	—	—	—	
	7–	2	3	—	—	—	—	
	8–	1	4	7	2	—	—	14
	9–	1	6	1	10	—	—	18
	10–	—	2	10	17	7	—	36
	11–	—	1	5	20	8	—	34
	12–	—	—	3	10	4	—	17
	13–	—	—	—	12	1	—	13
	14–	—	—	—	3	1	—	4
	15–	—	—	3	6	1	—	10
Total for each grade or standard		4	16	30	80	22	—	152
School No. 6 (Elder boys).	11–	—	—	1	4	5	—	10
	12–	—	—	1	8	25	3	37
	13–	—	—	1	13	12	19	45
	14–	—	—	1	13	6	16	36
	15–	—	—	3	3	2	—	8
	16–	—	—	—	1	—	—	1
Total for each grade or standard		—	—	7	42	50	38	137

TABLE II.—DISTRIBUTION OF EDUCATIONAL ABILITY— SPECIAL (M.D.) SCHOOLS.

Totals for all Special (M.D.) Schools within the borough.

Table showing numbers of children at each age attaining the grade or standard indicated.

Age.	Grade 0.	Grade i.	Grade ii.	Grade iii.	Standard I.	Standard II.	Total for each age.
6—	—	—	1	—	—	—	1
7—	6	9	3	—	—	—	18
8—	10	18	11	2	—	—	41
9—	5	25	21	18	2	—	71
10—	2	14	41	39	14	—	110
11—	—	10	24	46	25	1	106
12—	—	3	12	34	36	5	90
13—	—	3	9	33	18	20	83
14—	—	—	8	18	9	17	52
15—	—	1	6	11	5	—	23
16—	—	—	—	1	—	—	1
Total for each grade or standard	23	83	136	202	109	43	596

TABLE III.—DISTRIBUTION OF EDUCATIONAL ABILITY— SPECIAL (M.D.) SCHOOLS.

Distribution of Ability within the several Schools.

Percentages in each school assigned to the grade or standard indicated.

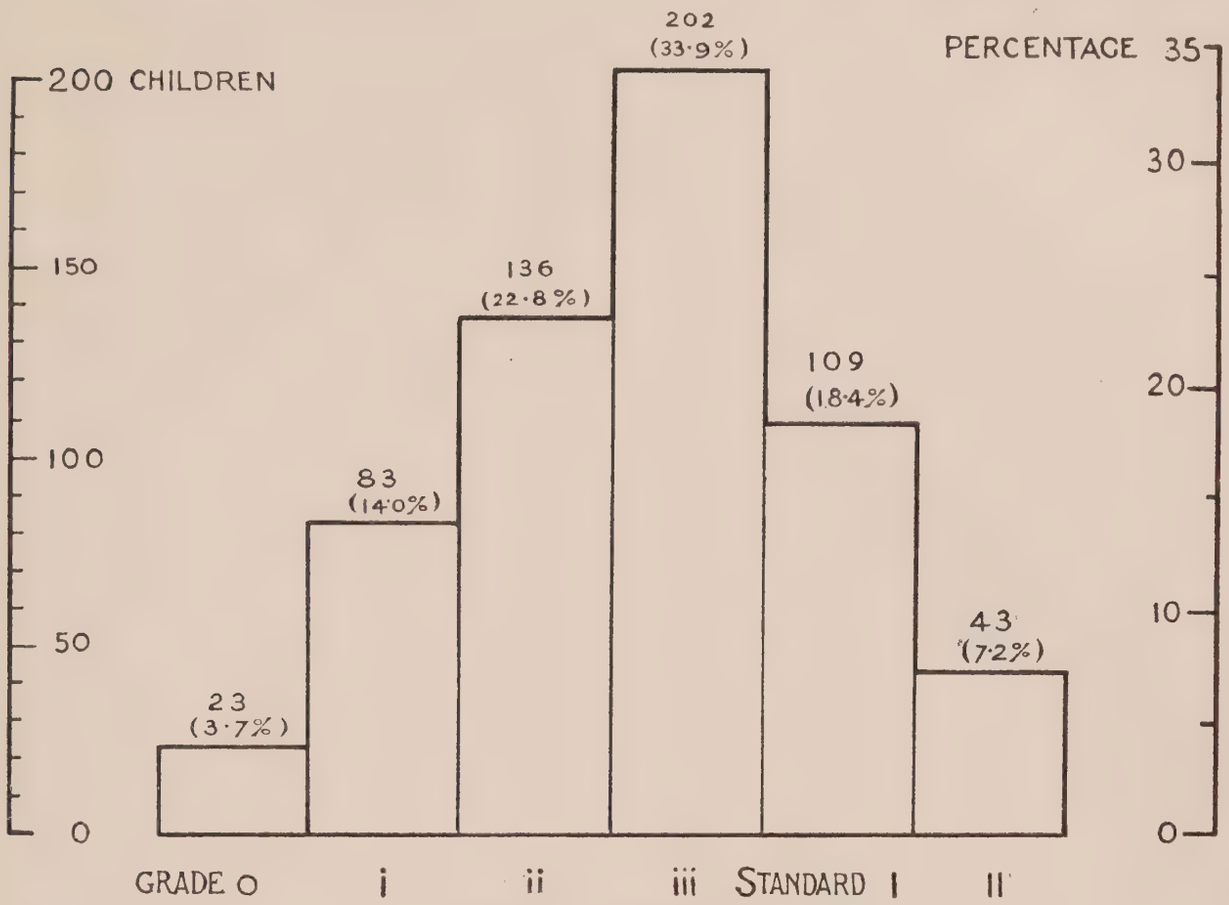
School.	Grade 0.	Grade i.	Grade ii.	Grade iii.	Standard I.	Standard II.	Total.
No. 1	7·4	27·4	35·8	24·2	5·2	0·0	100
No. 2	4·2	20·0	41·1	22·1	12·6	0·0	100
No. 3	10·8	29·3	21·5	24·6	10·8	3·0	100
No. 4	1·9	5·7	23·1	38·5	25·0	5·8	100
No 5	2·6	10·5	19·7	52·6	14·5	0·0	100
All Junior Schools ...	5·0	18·1	28·2	34·9	12·8	1·0	100
No. 6 (Elder Boys) ...	0·0	0·0	5·1	30·7	36·5	27·7	100
All Schools	3·7	14·0	22·8	33·9	18·4	7·2	100

FIGURE 1.

DISTRIBUTION OF EDUCATIONAL ABILITY AMONG THE MENTALLY DEFICIENT.

Special (M.D.) Schools of a Single Borough.

596 mentally deficient children. Number of children in each Grade and Standard.



Scale of Attainments.

TABLE IV.—SPECIAL (M.D.) SCHOOLS.

Average Degree of Educational Attainment and Deficiency at each Age.

	Age.	Educational Class.	Degree of Backwardness	Backwardness in terms of Standard Deviation of Normals.	Ratio of Educational Age to Physical Age.
	6·5 years	(Grade 2·50)	(−0·93 years)	(1·50 S.D.)	(85 per cent.)
	7·5 years	Grade 1·33	−3·04 years	4·82 S.D.	58 per cent.
	8·5 years	Grade 1·62	−3·72 years	4·96 S.D.	54 per cent.
	9·5 years	Grade 2·32	−3·95 years	4·34 S.D.	56 per cent.
	10·5 years	Grade 2·95	−4·27 years	3·88 S.D.	56 per cent.
	11·5 years	Grade 3·34	−4·80 years	4·10 S.D.	55 per cent.
	12·5 years	Grade 3·81	−5·19 years	4·40 S.D.	54 per cent.
	13·5 years	Standard 1·02	−5·76 years	4·64 S.D.	52 per cent.
	14·5 years	Standard 1·17	−7·03 years	(5·20 S.D.)	50 per cent.
	15·5 years	(Grade 3·37)	(−8·74 years)	(6·11 S.D.)	(41 per cent.)
	16·5 years	(Grade 3·50)	(−8·80 years)	(5·87 S.D.)	(39 per cent.)
Average for all children	11·59 years	Grade 3·20	−5·01 years	4·45 S.D.	54 per cent.

The figures in brackets are unreliable owing to the small numbers in the groups and to the unreliability of the estimated standard deviations of the normals obtained by smoothing the curve.

The figures for "backwardness" (column 3) have been calculated by taking the average "class" actually found for the several age groups among normal children (Table X, column 3), and from these subtracting the average "class" of the defectives (column 2). The average given at the foot of this column is the weighted average of the figures above; taking one grade as equal to one year, either in the average of column 2 or in Table V., yields a somewhat higher figure, namely, −5·40. The line drawn in Figure 2, Diagram B, represents a compromise between these two estimates.

Measures of Amount of Deficiency.

To compare children of different ages and of different schools, we need some method of describing and measuring the degree of educational level or deficiency. Four methods at least are available:—

1. The Educational Class and Educational Age.
2. The Educational Retardation, measured in Years.
3. The Educational Deviation, measured in terms of the Standard Deviation of Normal Children of the same Age.
4. The Ratio of Educational Age to Physical Age.

Differences in Measurements of Deficiency at each Age.

The way in which the several measures of deficiency vary with age is shown in Table IV., and can be well observed by inspecting the points plotted in Diagrams A, B, C and D of Figure 2.

1. Educational "Class" and Educational "Age" of Defectives.

Of the various methods of measurement available, the first and most direct is the grade or standard to which each child is assigned. For purposes of averaging, the series of grades and standards may, as we have seen (p. 6), be treated as a continuous scale. This measure may be called the "Educational Class" or Grade. Were the child placed in a class of an ordinary elementary school, exactly corresponding to his attainments, then his educational class would be identical with his school class.

His "Educational Age" may be calculated directly from his educational class. If the latter is measured in standards, the corresponding age is obtained, approximately, by adding 6, since 6 would be the average age of normal children in standard 0. If the educational class is measured, not in the "Standards" of a senior department, but in the "Grades" of an infants' department, then the corresponding age is obtained, approximately, by adding 3, since 3 would be the average age of normal children in grade 0. More exact purposes require the use of regression equations calculated from the correlation between class and age.[1]

The average educational grade of all the special school children is Grade 3·20 (Table IV., Figure 2, A). That is to say, the average attainments of "defectives" roughly correspond to those of "normals" in the lower half of grade iii. in an ordinary infants' department, a group whose normal age is about six and a quarter. At the moment of investigation, none of the special school children have reached a level higher than that of standard II. If we except the older children, hardly any reach a level higher than that of standard I. To grades ii. and iii. nearly two-thirds of the juniors are assigned. The elder children are assigned in nearly equal proportions to grade iii., to standard I. and to standard II. (Table III. and Figure 1).

It will be seen, however, that the grade of attainment increases almost in direct proportion to age (Figure 2, A). For practical purposes, the grades or standards to which "defectives" upon an average correspond at different ages may be taken as indicated in the following list:—

Defectives aged	7 to 8	correspond to a	lower	grade	i.	(normal age,			4¼	years).
„ „	8 to 9	„ „	upper	grade	i.	(„	„		4¾	years).
„ „	9 to 10	„ „	lower	grade	ii.	(„	„		5¼	years).
„ „	10 to 11	„ „	upper	grade	ii.	(„	„		5¾	years).
„ „	11 to 12	„ „	lower	grade	iii.	(„	„		6¼	years).
„ „	12 to 13	„ „	upper	grade	iii.	(„	„		6¾	years).
„ „	13 to 15	„ „	lower	standard	I	(„	„		7¼	years).

(1) See *Memorandum* II., p. 24.

SPECIAL M

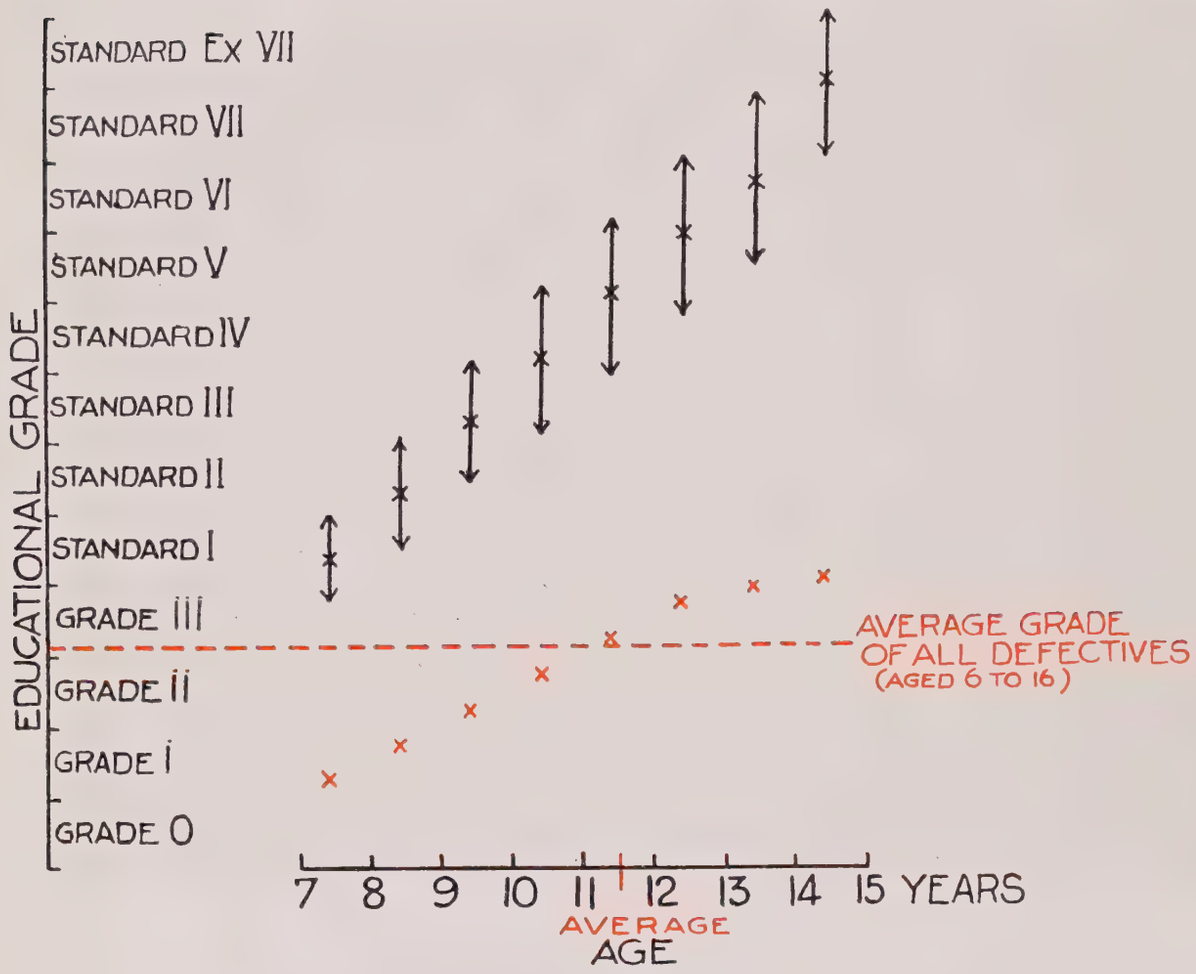
MEASUREMENTS OF EDUCATI

VALUES FOR 'I
VALUES FOR 'I

A.—DEVELOPMENT

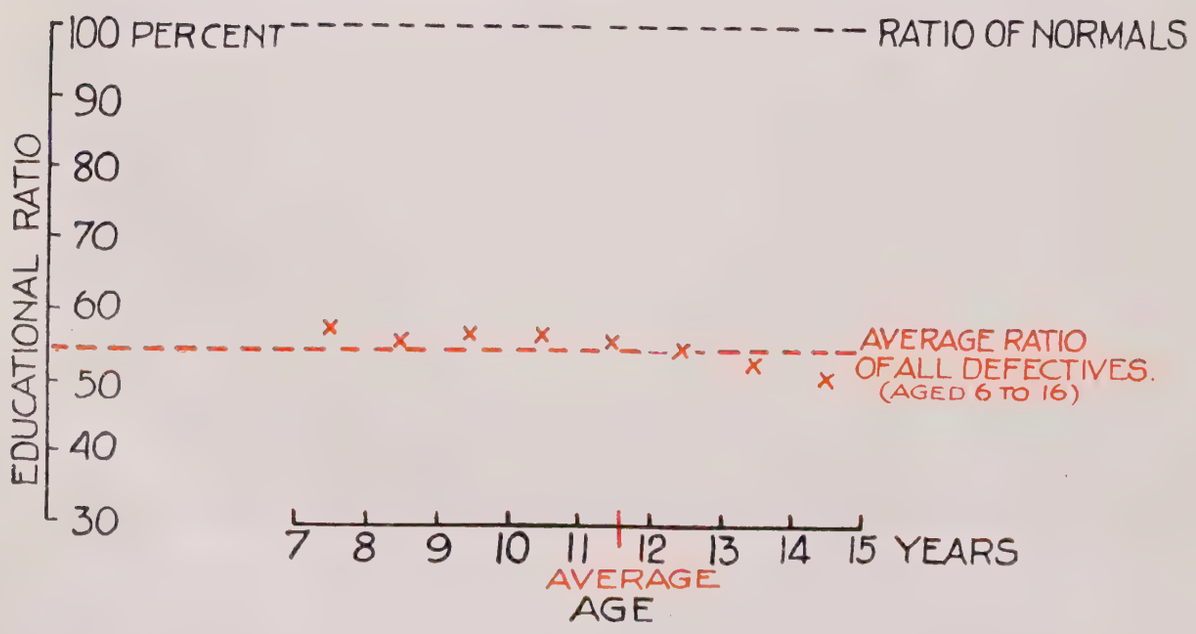
OF 'DEFECTIVES' AS COMPARED WITH NORMALS.

THE ARROWHEADS REPRESENT THE LIMITS OF THE 'STANDARD' DEVIATION OF THE NORMALS.



D.—RATIO OF ATTAINMENTS TO AGE.

RATIO OF 'NORMALS' TAKEN AS 100.



re 2.

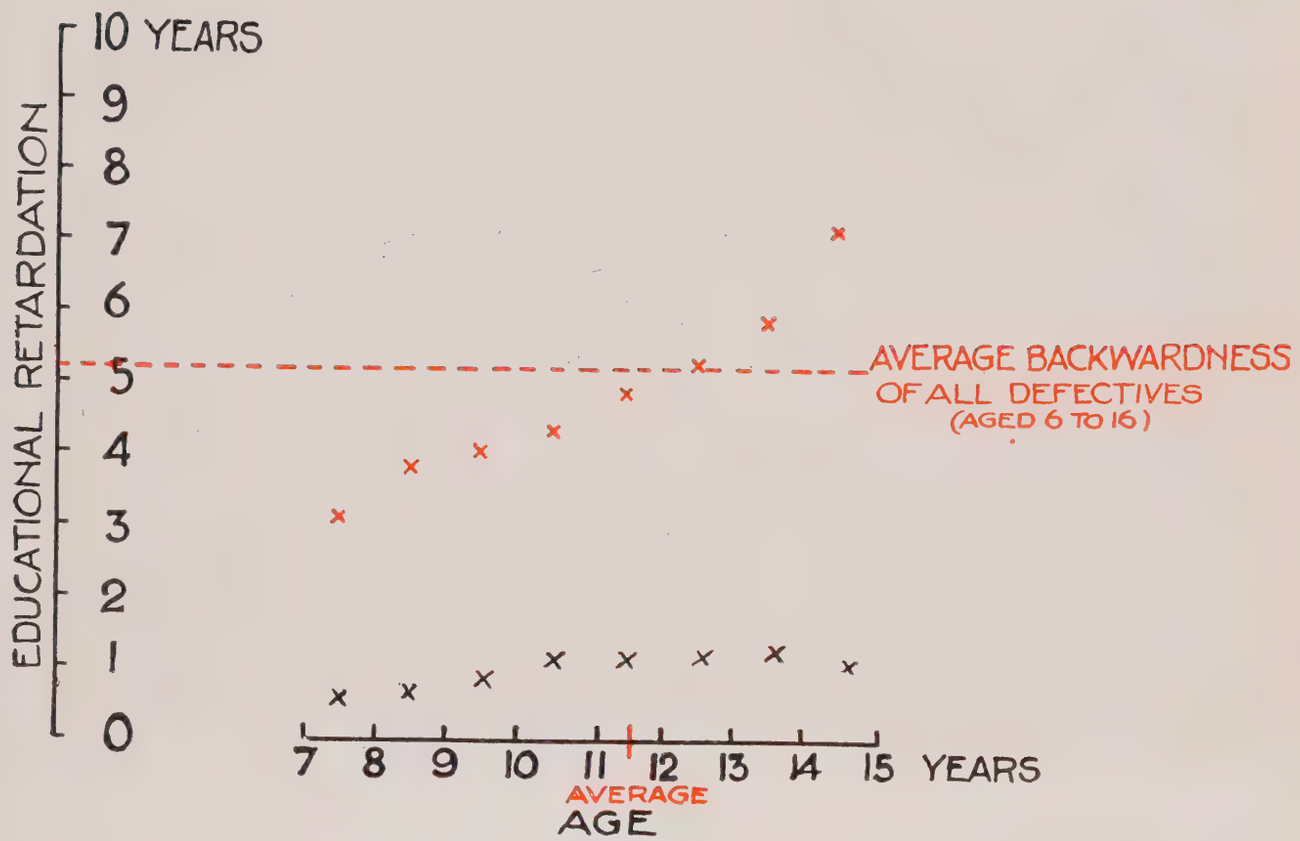
. SCHOOLS.

IAL DEFICIENCY AT EACH AGE.

CTIVES' IN RED.
MALS' IN BLACK.

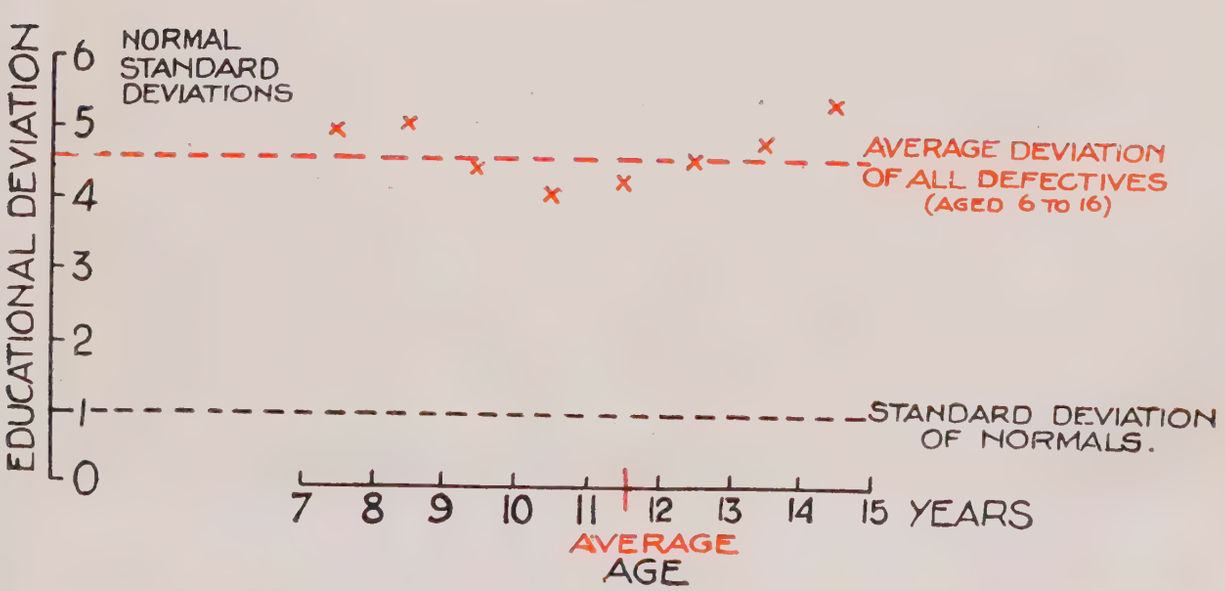
B.—BACKWARDNESS

OF 'DEFECTIVES' AS COMPARED WITH 'STANDARD' DEVIATION OF NORMALS.



C.—DEVIATION OF 'DEFECTIVES.'

'STANDARD' DEVIATION OF 'NORMALS' TAKEN AS UNITY.



The educational progress of "defectives" thus follows an average rate of about half a class (grade or standard) per annum—a rate of progress which is about half that of ordinary elementary children. The general course of their development may be inferred from the series of points plotted in Figure 2, A. The curve is slightly convex. With defectives, therefore, educational development is not only slower; it also seems to slacken and cease towards the end of the school career. Many doubtless arrive prematurely at the limit of their mental growth.[1]

2. Educational Retardation of Defectives.

By subtracting his real age from his educational age, a child's divergence from the normal can be measured in educational years. If the difference is negative, the child is backward or retarded; if positive, forward or advanced; if zero, level.[2]

The distribution of backwardness in the special (M.D.) schools is shown in Table V. For brief reference it is convenient to describe such a table as a "Retardation Table." A retardation table for intelligence, based upon the application of Binet's tests to special (M.D.) schools, has already been published in my first report.[3] Educationally, all appear more or less retarded. Out of the 596, all but eight are retarded by at least two years. Nearly two-thirds are backward by four to six years. One is backward by as much as eleven.

On an average, special school children are retarded by about five years. The amount of backwardness increases very remarkably from 3 years at the age of seven, to nearly 9 at the age of sixteen. (Table IV., column 3; Figure 2, diagram B.) Among normal children so great a degree of backwardness is extremely rare. In the whole borough, comprising nearly thirty-two thousand children, it is exhibited by only thirteen, or 0·04 per cent. The average (arithmetic mean) degree of backwardness of the backward half of all the normals is only four-fifths of an educational year or grade; the average ("standard" or root-mean-square) deviation of the entire group of normals is only 1·06 year.[4]

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(1) This convexity is attributable to administrative reasons as well as to psychological. Many of the brighter defectives leave school at a somewhat earlier age.

(2) In *Memoraudum* II., "backward" is ultimately given a technical and limited connotation, namely, retarded by the equivalent of 1½ to 3 years at age 10 (p. 36). For negative differences generally, the clumsier phrase "behind age" is used. This covers every degree of retardation, whether serious or negligible, administratively significant or not. An analogous distinction might be drawn between those who are merely "above age," and those who are definitely "advanced," *i.e.*, above age by at least 1½ years, and among the top 7 or 10 per cent.

(3) *Report by the Council's Psychologist*, February, 1915, p. 2.

(4) It is of interest to compare the degree of educational backwardness exhibited by defectives with their degree of physical backwardness. In an appendix I have added a preliminary note on this problem. In height they appear on an average to be retarded by two-thirds to three-quarters of a year; in weight by one-half to one-third of a year. The subnormality is somewhat greater in head measurements, and greater still in physiological measurements. But the differences are throughout small and inconstant. *In physical development, therefore, special school children appear on the whole to be somewhat backward. But except for a few individual cases, the physical retardation is insignificant compared with the retardation in education or intelligence.*

Deficiency in height or weight is in itself not diagnostic of mental defect. It appears slightly correlated with degree of backwardness. Deficiency in functional or "physiological" tests is somewhat more significant. Still more significant is a deficiency in functional measurements which markedly exceeds the deficiency in structural measurements. Of the non-psychological measurements the maximal circumference of the head is one of the most rapid, most convenient, and at times most suggestive. My data are at present too limited for publication in full. For normal boys the average increases from 51·9 cm. (at 7) to 53·8 cm. (at 14). With defectives it is from 1·2 to 2·0 cm. less, according to age. Girls of either group average about 1·0 to 0·5 cm. less than the boys. Defectives thus appear about 4 or 5 years backward in head development. This nearly corresponds with Binet's limit of normality for cranial circumference (6 years retardation). Measurements below 49 cm. are rare among normal boys in senior departments, and therefore strongly suggest defect. They are not common in special schools. Here as in all else defectives vary far more about their average than do normals.

TABLE V.—SPECIAL (M.D.) SCHOOLS

Distribution of Backwardness

Table showing number of children at each age below the average educational level for

Age.	Degree of				
	– 11	– 10	– 9	– 8	– 7
6 —	...	...	...	...	...
7 —	...	...	...	...	...
8 —	...	...	...	...	...
9 —	...	...	...	...	...
10 —	...	...	...	...	2 (2)
11 —	...	...	...	...	10 (9)
12 —	...	...	...	3 (3)	12 (13)
13 —	...	...	3 (4)	9 (11)	33 (39)
14 —	...	...	8 (15)	18 (35)	9 (17)
15 —	1 (4)	6 (26)	11 (48)	5 (22)	...
16 —	...	1 (100)	...	...	...
Total for each degree of backwardness.	1 (0·2)	7 (1·2)	22 (3·7)	35 (5·9)	66 (11·0)

("RETARDATION" TABLE).

in Educational Ability.

their age by the number of years indicated. Figures in brackets give percentages.

Backwardness.						Total for each Age.
- 6	- 5	- 4	- 3	- 2	- 1 years.	
...	...	...	...	...	1 (100)	1 (100)
...	...	6 (33)	9 (50)	3 (17)	...	18 (100)
...	10 (24)	18 (44)	11 (27)	2 (5)	...	41 (100)
5 (7)	25 (35)	21 (30)	18 (25)	2 (3)	...	71 (100)
14 (13)	41 (37)	39 (35)	14 (13)	...	...	110 (100)
24 (23)	46 (43)	25 (24)	1 (1)	...	...	106 (100)
34 (38)	36 (40)	5 (6)	...	...	...	90 (100)
18 (22)	20 (24)	...	...	...	...	83 (100)
17 (33)	...	...	...	...	...	52 (100)
...	...	...	...	...	...	23 (100)
...	...	...	...	...	...	1 (100)
112 (18·8)	178 (29·8)	114 (19·1)	53 (8·9)	7 (1·2)	1 (0·2)	596 (100)

Inadequacy of the above Measures.

Of the various methods of estimating deficiency, the foregoing are in commonest use. They are analogous, in the case of educational deficiency, to the two suggested by M. Binet for the measurement of deficiency in intelligence.

(i) To mark off the feeble-minded, he originally proposed two mental age limits: the mental age of eight divided them from the normal, and that of five distinguished them from the imbecile. The proposal implies that the "defective" is one whose mental development has followed that of the normal up to a certain age and then has been prematurely arrested. We have seen, however, that the "defective" drops behind almost from the start. Hence, not only his educational age but also his actual age must be taken into account. A "defective" assigned to the level of grade iii. is plainly convicted of a far greater deficiency if his age is 16 than if his age is 8.

(ii) To meet these objections, M. Binet, in his later definitions, substituted the conception of backwardness or retardation in place of the mental age limits. A child was to be regarded as defective if he was backward by three years or more. This second proposal suggests that the "defective" begins to develop two or three years later than the normal, and that he then follows a parallel course at a uniform distance behind. Once more, however, the development suggested seems true of a small proportion only. With the majority the degree of backwardness increases progressively from year to year. A child of sixteen may be backward by ten years or more, whereas a child of six obviously cannot be more than six years behindhand. A child of fourteen in standard IV. probably has a far less serious defect than a child of ten in grade iii., although both are retarded by four years. Binet's second proposal, therefore, seems as unfair to older children as his first was to younger. According to the first proposal, it would be possible for children to be regarded as defectives till they reached a given mental age and then to become normal: according to the second proposal, they might be normal during the earlier years of life, and then become, first, feeble-minded, and, eventually, imbecile.[1]

We need, therefore, some measure of deficiency from which has been eliminated all influence of age.

3. Educational Deviation of Defectives as compared with that of Normals.

A simple technical device would be to take as unit the average (or "standard") deviation of normal children belonging to the several age-groups and then to reduce to terms of these units the deviations of the "defectives," originally expressed in years. The reduction is familiar in statistics. Measurements of height, weight, speed, attainment or ability, obtained originally in disparate units—inches, pounds, seconds, marks, or mental years—are first converted into multiples of the standard deviation of the whole group; they can then be added, averaged, and compared, like all measurements formulated in terms of the same scale.

From the figures obtained from the survey of the ordinary elementary schools[2] it appears that, on an average,[3] a normal individual deviates from

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(1) Evidently anticipating the foregoing difficulties, Binet introduced yet a further modification into his formula: with children of eight or under a retardation of two years in school studies is sufficient to indicate feeble-mindedness. Clearly his published definitions were practical compromises, intended merely for utilitarian purposes. It is, therefore, not so much Binet's personal views that are to be criticised, as the inaccurate theories that have developed from a rigid adherence to his simplified rules.

(2) See *Memorandum* II., p. 24.

(3) I use this expression somewhat loosely to avoid a technical circumlocution, which, though more exact, might be less intelligible to those unversed in statistical terms. Strictly speaking, one-tenth is not the average deviation, in the sense of the "mean" deviation, but the "standard" or "root-mean-square" deviation. For the difference between the methods of calculating the two, see *Memorandum* II., p. 31.

the average of his age-group by about one-tenth of his age (Table X., column 4); the actual values for each age are plotted as the lower row of points in Figure 2, B. Expressed as a multiple of these normal values, the deviation of the "defectives" varies but little, if at all, with age. The figures for the various ages are given in the fourth column of Table IV., and are illustrated in Figure 2, C. The small fluctuations observable are chiefly due to irregularities in the values found for the normal standard deviations. *On an average, the deviation of the "defectives" from the normal level is about four and a half times that of the "normals."* It is always in a negative direction, *i.e.*, towards a lower educational grade.

4. Ratio of Defectives' Educational Age to their Physical Age.

Measurements in terms of the standard deviation are somewhat technical and elaborate. The "Educational Ratio" is more readily understood.

To be considered normal, a child of ten should have (within certain limits yet to be defined) the educational attainments of an average child of ten. A "defective" has only a fraction of those attainments. This fraction may be called his "educational ratio." Thus, if he is in grade ii., instead of in his proper standard IV., he has acquired the equivalent of only five years' education instead of ten. His educational ratio, therefore, is five-tenths, or 50 per cent.

Among special school children, the average educational ratio is 54 per cent. (Table IV., column 5; Figure 2, diagram D). That is to say, *they have acquired but little more than one-half of the educational attainments achieved by normal children at a corresponding age.* The ratios vary but little with age. If anything, they show a slight tendency to decline.

Since the standard deviation of a normal age-group varies in almost direct proportion to the group's average age, the statistical requirements of the educational deviation are largely fulfilled by the educational ratio. At the same time, the ratio is simple in calculation; it is not disturbed by observational errors in the standard deviation; and, finally, it conveys an obvious concrete meaning.

Hence, as a single criterion of deficiency, directly applicable irrespective of age, the educational ratio is, perhaps, the most convenient.[1]

Differences in Measurements of Deficiency at Different Schools.

The need of these subtler measures becomes evident in any attempt to compare the degree of deficiency prevalent at different schools. The average Age, Grade, Retardation, Deviation and Ratio found at each school is given in Table VI. The grade and retardation is clearly determined in part by the different age-composition of the several schools. Judged by the average deviation and ratio, the differences between the schools are comparatively small. If anything, School No. 1 contains children whose deficiency is greatest; here the largest percentages are in grades i. and ii., though this low assessment is somewhat mitigated by lower age (Table III.). The difference in the figures for the several schools, however, may be slightly influenced by differences in the standard adopted by the different teachers. This question, therefore, is better deferred for examination until the tests have been more fully and frequently applied.

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(1) Those familiar with recent psychology will rightly surmise that, for theoretical as distinct from practical purposes, the educational ratio, as a means of measuring scholastic ability, is open to much the same objections as the "intellectual quotient" recommended by Stern, as a measure of general ability or intelligence. For scientific work the employment of the standard deviation seems indisputably the best device.

TABLE VI.—SPECIAL (M.D.) SCHOOLS.

Educational Deficiency at Different Schools.

The figures are presented merely to illustrate possible methods of comparison. Final estimates can be based only upon actual tests.

School.	Average Age.	Average Class.	Average Backwardness.	Average Deviation.	Average Ratio.
No. 1 ...	10·49 years ...	Grade 2·40 ...	5·73 years ...	5·2 S.D. ...	48 per cent.
No. 2 ...	11·25 years ...	Grade 2·69 ...	5·15 years ...	4·6 S.D. ...	51 per cent.
No. 3 ...	11·46 years ...	Grade 2·58 ...	5·25 years ...	4·5 S.D. ...	49 per cent.
No. 4 ...	10·93 years ...	Grade 3·04 ...	4·17 years ...	4·1 S.D. ...	54 per cent.
No. 5 ...	11·21 years ...	Grade 3·16 ...	4·64 years ...	4·1 S.D. ...	54 per cent.
No. 6 ...	13·49 years ...	Standard 1·37	5·60 years ...	4·1 S.D. ...	56 per cent.

The averages in this table have been based on estimates of educational class and backwardness made for each individual child; and accordingly exhibit slight inconsistencies both with each other and with deductions from Table I. Thus, in accordance with the simple suggestions of the preceding paragraphs (Educational Age = Grade + 3; Backwardness = Physical Age − Educational Age), we should expect the average backwardness in school No. 1 to be about 5·09 years instead of 5·73. These slight discrepancies indicate how tentative are our methods both of assessment and of calculation.

Conclusion as to Educational Deficiency of Defectives.

The foregoing results may be summed up as follows:—

The educational attainments of a so-called mentally defective child correspond on an average to those of an ordinary child of just over half his age. Thus, a "defective" of ten will have the educational attainments of an ordinary child of five or six, corresponding to the level of about grade ii. He will be backward by nearly five years. Since the average deviation of a normal group is about one-tenth of their age, and one-tenth of ten is one, he will probably deviate from the normal level for his age by about five times as much as a chance-selected normal ten-year old; and he will always deviate below the normal level. We have thus a simple rule for predicting the most probable degree of educational deficiency for any special school child of a given age.

Comparison of Educational Deficiency with Deficiency in General Intelligence.

It is interesting to compare the amount of retardation in educational attainments with the amount of retardation in general intelligence. Tables for the latter have already been submitted for some of the schools in this borough; others will be given in later reports.[1] From a comparison of the tables it is obvious that *the amount of retardation in educational attainments is far greater than that in general ability;* children in special schools are characterised more by backwardness in school work than by defective intelligence. Defective intelligence is usually accompanied by extremely defective attainments; but defective attainments are by no means an invariable index of an equal defect in intelligence.

Definition of Special (M.D.) School Cases.

Defective intelligence then is far from being completely correlated with defective educability. This increases the difficulty of a practical definition

(1) Compare also *Report by the Council's Psychologist*, February, 1915, Table on p. 2 and Diagram on p. 5.

of mental deficiency. Upon administrative grounds there are strong arguments for instructing in special classes or schools those who are extremely backward educationally. But upon both social and psychological grounds there is little to be said for designating as "mentally deficient" those whose defect is chiefly educational. This is rendered still less advisable by the standpoint taken in the Mental Deficiency Act, 1913. According to its definition, before adults can be deemed defective, there must exist, "from birth or from an early age," a defectiveness, presumably "permanent," and at least "so pronounced that they require care, supervision, and control, for their own protection or for that of others." Here the meaning assigned to the term is in rough agreement with that implied in psychological discussions. In psychology, it appears to connote an inborn deficiency of general intelligence, due, it is believed, to a general low development of the newest cell-layers of the brain. Often it also includes cases of acquired instability of mental behaviour, due, it is maintained, to early degeneration of the newer and newest cell-layers, whose general durability has been insufficient to resist the organic or functional strain imposed upon them. Educational deficiency, on the other hand, is attributable to a variety of alternative causes. Where inborn, it is probably due to a defect far more limited in character; and is quite compatible, though seldom actually associated, with a general intelligence that is completely normal. Where acquired, it may result from inadequate or excessive mental stimulation; or, more commonly, from some form of physical deficiency—the brain (in popular language) may have been ill-nourished, particularly perhaps during infancy; or it may have been poisoned, perhaps before birth, or later through some infectious illness; or again its action may be disorganised by inadequate or excessive secretions poured into the blood-stream by inefficient glands.[1]

The causes of "deficiency," and in particular the relations between physical, psychological, and educational deficiency, thus form an urgent field for research. "Mental deficiency" in the strict technical sense is clearly but one of the many possible reasons why a child has ultimately been admitted to a special (M.D.) school.[2]

The Problem of the Upper Limit of Educational Deficiency.

For simplicity, then, we may assume that special school cases are selected primarily because "incapable of receiving proper benefit from the instruction in the ordinary public elementary schools." We have now to determine what line can be drawn between capability and incapability. Are the incapable sharply separated from the capable, or do the two groups merge and overlap? Where does the line at present appear to be drawn? Where should it be drawn so as to fill the existing accommodation with a minimum of overlap? What proportion of incapables, if any, will then be left in the ordinary schools?

These problems can be solved only by a comparative survey of ordinary school children upon the same lines as the children in special (M.D.) schools.

(1) An interesting light is thrown upon these distinctions by investigations into the early development of special school children. Where educational deficiency is associated with sub-normal intelligence, and both appear either inborn or early acquired, there the child is commonly found to have been backward in beginning to walk and talk and in learning habits of cleanliness. In a group of about 50 such cases, the average age of learning to walk was 1·93 years, to talk 2·36 years; for normals, the ages were 1·09 and 1·25, respectively. Thus, the defective group was backward by nearly half their age,—the backwardness being greatest in the case of talking. In other kinds of special school cases, the backwardness is by no means so marked; commonly, the child is said to nave commenced to walk and talk "about the same age as other children." Here, it is interesting to note, the effects of special school treatment appear to have been much more successful.

(2) *Cf.* Elementary Education (Defective and Epileptic Children) Act, 1899. It may be noted that the definition given in this Act does not apparently require the mental defect either to be permanent or to have existed from birth or from an early age.

MEMORANDUM II.

DISTRIBUTION OF EDUCATIONAL ABILITY AMONG CHILDREN IN *ORDINARY ELEMENTARY SCHOOLS.*

Objects of Survey of Normals.

To complete any study of educational deficiency in special schools, it becomes essential, as we have seen, to make a comparative survey of children presumably normal. Only by comparison with "normals" can we state what characteristics differentiate the backward or deficient. Only after a review of the joint population can we estimate the numbers thus differentiated and so requiring accommodation in special classes or in special schools. The problems to be investigated in the ordinary schools are three. First, what educational level is normally attained by children at each age? Secondly, to what extent do children normally vary above and below that average? Thirdly, what are the limits beyond which extreme variations must be judged abnormal?

Data.

All the children upon the roll of the ordinary elementary schools of the borough selected have been classified in the same terms as the special school children. The estimates have been obtained by an "extensive" survey, checked by a system of "intensive" observations and tests.

"Extensive" Survey based on Distribution by Age and Class.

Owing to the large numbers involved, it proved impossible, and indeed unnecessary, to make a separate estimate for each individual child. Preliminary experiments suggested that the actual classes in which children are working may be taken as an approximate index of their educational ability, once the composition of the classes,—their level and their heterogeneity,—are ascertained. Accordingly, returns were obtained, either direct from the school or from the annual age-and-standard schedule, showing the number of children at each age working in the several classes. An estimate of the general level of each class, expressed in terms of the grade-and-standard scale, was furnished by the head teachers. Heterogeneous classes—*i.e.*, those including several standards—and intermediate classes—*i.e.*, those falling between two successive standards—were noted as such; and the children were divided in appropriate proportions among the several standards over which they ranged or between which they fell. The results were then tabulated anew as an age-and-ability schedule for each department and school.

"Intensive" Controls in Selected Schools.

Two methods of checking the results were employed:—

(1.) At certain schools, lists were obtained of all children above or below the level of their class in one or more subjects by one or more years. Many older children, who were especially backward, were found to be working in classes somewhat above their educational level: and many younger children, who were especially advanced, to be working in a class somewhat below.

(2.) At certain schools, chosen as lying near the middle or either extreme of the scale of educational efficiency, scholastic tests (for Composition, Arithmetic, Reading, Dictation and Drawing) were applied either throughout or to representative individuals. The standard of assessment was thus kept more nearly comparable in the more exceptional schools. At the same time, it was found that within a given class attainments often varied still more widely than the teachers themselves were aware.

The variations thus revealed prove in the long run fairly regular. Where adjacent classes overlap, the variations largely neutralise each other. At the ends of the scale, where there is no class to overlap, the proportions falling outside the conventional limits can be calculated with but a small margin of error. Throughout the investigation, however, the original estimates have been modified as little as possible. Inexactitude involved in the "extensive" survey seems best reserved for separate consideration in the light of the "intensive" studies by experimental tests. In a later memorandum, therefore, I shall consider the amount of heterogeneity and overlapping exhibited in school classes.[1] With the treatment here adopted, the true averages throughout probably emerge with little or no distortion: but the variation about the average is doubtless left somewhat reduced.

Age-and-Ability Tables.

The figures have been analysed separately for Boys' and Girls' departments in Council and Non-provided schools. The data are given in Tables VII. and VIII. The totals for all ordinary elementary schools within the borough (central schools included) are given in Table IX. The table may be regarded as a vast age-and-standard schedule for the whole borough, except that the standards now indicate estimated ability rather than actual class organisation. Where ambiguity is likely to arise, the measurements might be described as referring to the children's "educational grade" rather than their "standard" or their "class." Throughout, both age and ability refer to the age and level reached on the date on which this part of the investigation was commenced, namely, 31st January, 1915.

Distribution of Age in the Various Classes.

In studying a given class teachers occasionally make an analysis of the number of children of each age. A child is then considered backward because his age is too high for his class. In studying a whole school or district it is more profitable to invert this procedure. I shall, therefore, rather take the children by age-groups, and analyse graphically the number of children in the several classes who are all of the same age. The former question—the distribution of age among children of the same ability or class—I shall take up later in discussing heterogeneity and overlap.[2]

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(1) See *Memorandum* III., pp. 66, 72. (2) See *Memorandum* III., pp. 69–72, and Appendix II., pp. 89–93.

TABLE VII.—ORDINARY ELEMENTARY SCHOOLS.

A.—Council Schools (including Central Schools).

Table showing numbers of children at each age attaining the grade or standard indicated.

	Age.	Gr. i.	Gr. ii.	Gr. iii.	St. I.	St. II.	St. III.	St. IV.	St. V.	St. VI.	St. VII.	St. Ex-VII.	Above St. Ex-VII.	Total for each age.
	3—	81	1	—	—	—	—	—	—	—	—	—	—	82
	4—	374	74	—	—	—	—	—	—	—	—	—	—	448
	5—	193	834	214	—	—	—	—	—	—	—	—	—	1,241
	6—	16	227	931	181	12	—	—	—	—	—	—	—	1,367
	7—	—	27	311	813	204	12	—	—	—	—	—	—	1,367
	8—	—	1	35	406	621	210	46	1	—	—	—	—	1,320
I. Boys.	9—	—	—	6	109	358	456	252	51	2	—	—	—	1,234
	10—	—	—	3	33	162	378	409	208	66	5	—	—	1,264
	11—	—	—	—	7	34	166	331	364	267	87	—	—	1,256
	12—	—	—	—	2	9	59	176	312	400	318	30	—	1,306
	13—	—	—	—	1	3	29	80	158	281	483	141	36	1,212
	14—	—	—	—	—	—	1	3	6	7	39	91	45	192
	15—	—	—	—	—	—	—	—	—	—	3	26	37	66
Total for each grade or standard.	—	664	1,164	1,500	1,552	1,403	1,311	1,297	1,100	1,023	935	288	118	12,355
	3—	74	—	—	—	—	—	—	—	—	—	—	—	74
	4—	308	81	1	—	—	—	—	—	—	—	—	—	390
	5—	184	782	180	—	—	—	—	—	—	—	—	—	1,146
	6—	8	239	825	167	3	—	—	—	—	—	—	—	1,242
	7—	—	14	346	807	122	5	—	—	—	—	—	—	1,294
	8—	—	1	40	386	605	233	20	—	—	—	—	—	1,285
II. Girls.	9—	—	—	6	102	342	587	216	38	1	1	—	—	1,293
	10—	—	—	2	21	89	332	438	302	57	10	—	—	1,251
	11—	—	—	—	7	21	128	352	406	231	87	—	—	1,232
	12—	—	—	—	1	6	33	168	345	402	267	35	—	1,257
	13—	—	—	—	—	1	9	90	150	299	465	139	45	1,198
	14—	—	—	—	—	—	—	4	4	15	64	85	57	229
	15—	—	—	—	—	—	—	—	—	—	2	16	55	73
Total for each grade or standard.	—	574	1,117	1,400	1,491	1,189	1,327	1,288	1,245	1,005	896	275	157	11,964

TABLE VIII.—ORDINARY ELEMENTARY SCHOOLS.

B.—Non-Provided Schools.

Table showing numbers of children at each age attaining the grade or standard indicated.

	Age.	Gr. i.	Gr. ii.	Gr. iii.	St. I.	St. II.	St. III.	St. IV.	St. V.	St. VI.	St. VII.	St. Ex-VII.	Above St. Ex-VII.	Total for each age.
I. Boys.	3—	42	—	—	—	—	—	—	—	—	—	—	—	42
	4—	210	8	—	—	—	—	—	—	—	—	—	—	218
	5—	90	311	23	—	—	—	—	—	—	—	—	—	424
	6—	1	102	254	52	—	—	—	—	—	—	—	—	409
	7—	—	—	116	277	49	2	—	—	—	—	—	—	444
	8—	—	—	3	129	200	68	7	—	—	—	—	—	407
	9—	—	—	—	30	110	158	62	5	—	1	—	—	366
	10—	—	—	—	—	36	119	125	52	15	—	—	—	347
	11—	—	—	—	—	17	67	107	97	40	10	—	—	338
	12—	—	—	—	—	—	29	64	114	90	32	1	—	330
	13—	—	—	—	—	1	5	29	58	89	113	12	—	307
	14—	—	—	—	—	—	—	—	—	1	3	1	—	5
Total for each grade or standard.	—	343	421	396	488	413	448	394	326	235	159	14	0	3,637
II. Girls.	3—	38	—	—	—	—	—	—	—	—	—	—	—	38
	4—	180	4	—	—	—	—	—	—	—	—	—	—	184
	5—	77	297	34	—	—	—	—	—	—	—	—	—	408
	6—	1	113	277	63	5	—	—	—	—	—	—	—	459
	7—	—	2	98	295	67	3	1	—	—	—	—	—	466
	8—	—	—	9	154	188	47	1	—	—	—	—	—	399
	9—	—	—	3	45	128	187	47	6	1	—	—	—	417
	10—	—	—	1	15	73	135	167	44	16	6	—	—	457
	11—	—	—	—	1	17	73	152	127	39	17	—	—	426
	12—	—	—	—	—	10	21	93	136	93	44	—	—	397
	13—	—	—	—	—	3	15	43	82	101	93	9	—	346
	14—	—	—	—	—	—	—	—	3	3	5	—	—	11
	15—	—	—	—	—	—	—	—	—	—	1	—	—	1
Total for each grade or standard.	—	296	416	422	573	491	481	504	398	253	166	9	0	4,009

TABLE IX.—ORDINARY ELEMENTARY SCHOOLS.

C.—Total for all Schools.

Table showing numbers of children at each age attaining the grade or standard indicated.

	Age.	Gr. i.	Gr. ii.	Gr. iii.	St. I.	St. II.	St. III.	St. IV.	St. V.	St. VI.	St. VII.	St. Ex-VII.	Above St. Ex-VII.	Total for each age.
	3—	235	1	—	—	—	—	—	—	—	—	—	—	236
	4—	1,072	167	1	—	—	—	—	—	—	—	—	—	1,240
	5—	544	2,224	451	—	—	—	—	—	—	—	—	—	3,219
	6—	26	681	2,287	463	20	—	—	—	—	—	—	—	3,477
	7—	—	43	871	2,192	442	22	1	—	—	—	—	—	3,571
	8—	—	2	87	1,075	1,614	558	74	1	—	—	—	—	3,411
	9—	—	—	14	287	938	1,388	577	100	4	2	—	—	3,310
	10—	—	—	6	68	361	964	1,140	605	154	21	—	—	3,319
	11—	—	—	—	15	89	434	942	994	577	201	—	—	3,252
	12—	—	—	—	3	25	142	501	907	985	661	66	—	3,290
	13—	—	—	—	1	8	58	242	448	770	1,154	301	81	3,063
	14—	—	—	—	—	—	1	7	13	26	111	177	102	437
	15—	—	—	—	—	—	—	—	—	—	6	42	92	140
Total for each grade or standard	—	1,877	3,118	3,717	4,104	3,497	3,567	3,484	3,068	2,516	2,156	586	275	31,965

Distribution of Educational Ability in the Various Age-Groups.

It is of practical importance to enquire whether the different degrees of ability or disability occur according to any definite principle or law. The frequencies with which various grades of ability are found at different ages are shown diagrammatically in Figure 3. For comparison, the range of the special (M.D.) school children is shown in red. With the children of the ordinary schools, the frequency diagrams begin, at ages three and four, by being highest over the lowest grade, *i.e.*, towards the left: they end at age fifteen by being highest over the highest standard, *i.e.*, towards the right. At either end of the series the distribution is thus strongly asymmetrical.

The asymmetry is chiefly due to two causes. The individuals measured are imperfect samples of their groups; and the scale by which they are measured is limited at either end.

For the years eleven to fifteen, the figures in every group drop with increasing abruptness towards the higher end of the scale. The places beyond belong to the brighter children of these ages. Of these many must have left for secondary and other higher schools. Of those remaining, some perhaps have not had an opportunity to develop their superior talent; it has been left unexploited, while the mediocre and mildly backward children have been pushed up to a "good average." With others, standard VII. or Ex.-VII. appears to mark the upper limit of educational growth. A few perhaps have been underestimated. The scale proposed for the use of teachers included higher levels than standard VII.; but many may have hesitated to avail themselves of an unfamiliar class. A harder standard of comparison, too, appears to have been adopted in judging children in central schools.

Ages three and four end abruptly on the opposite side, namely, towards the lower end of the scale. Here the individual differences seem too small to be measured in educational years. But once more the samples available form small and selected groups; at the lower non-compulsory ages, probably the most backward are not sent to school. Moreover, the lower

Figure 3.

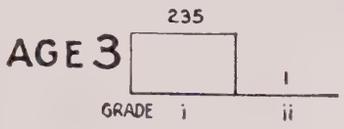
DISTRIBUTION
ACCORDING TO
EDUCATIONAL ATTAINMENT AT EACH AGE

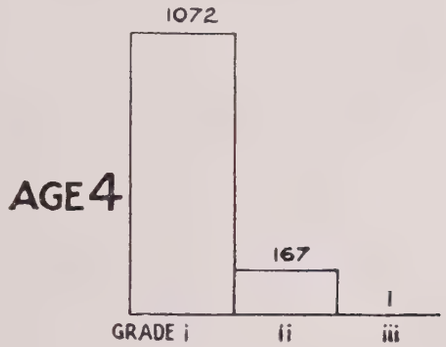
OF NORMAL AND MENTALLY DEFECTIVE CHILDREN
ATTENDING ELEMENTARY (ORDINARY, CENTRAL AND MENTALLY DEFECTIVE) SCHOOLS
WITHIN A SINGLE REPRESENTATIVE BOROUGH

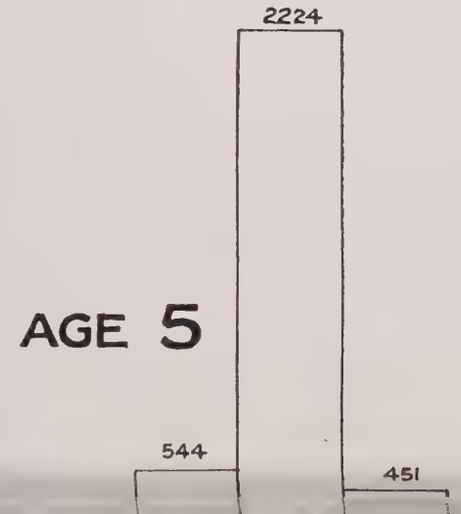
NUMBER OF CHILDREN :—

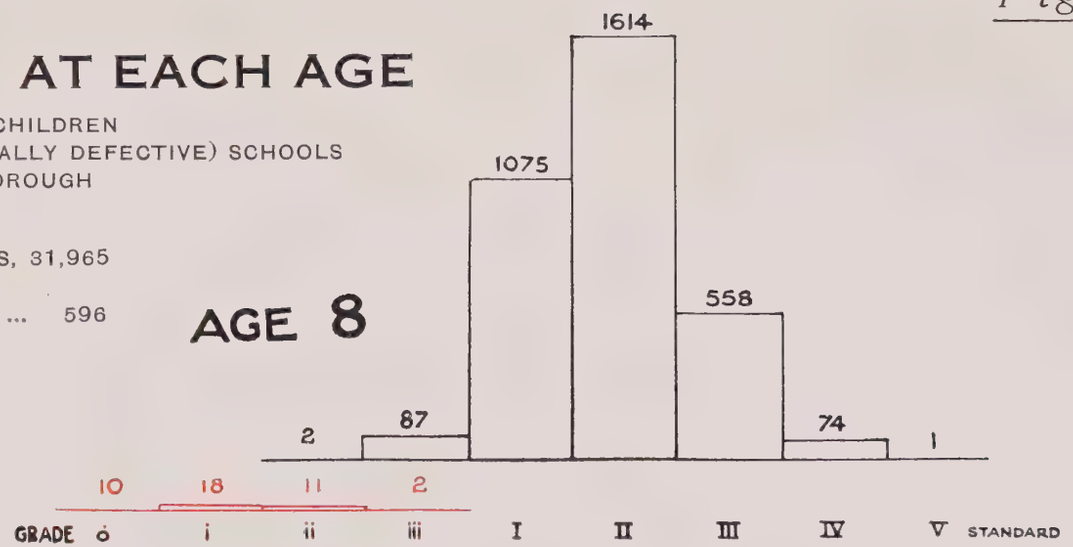
ORDINARY (INCLUDING CENTRAL) SCHOOLS, 31,965
Represented by **BLACK** *Outline*

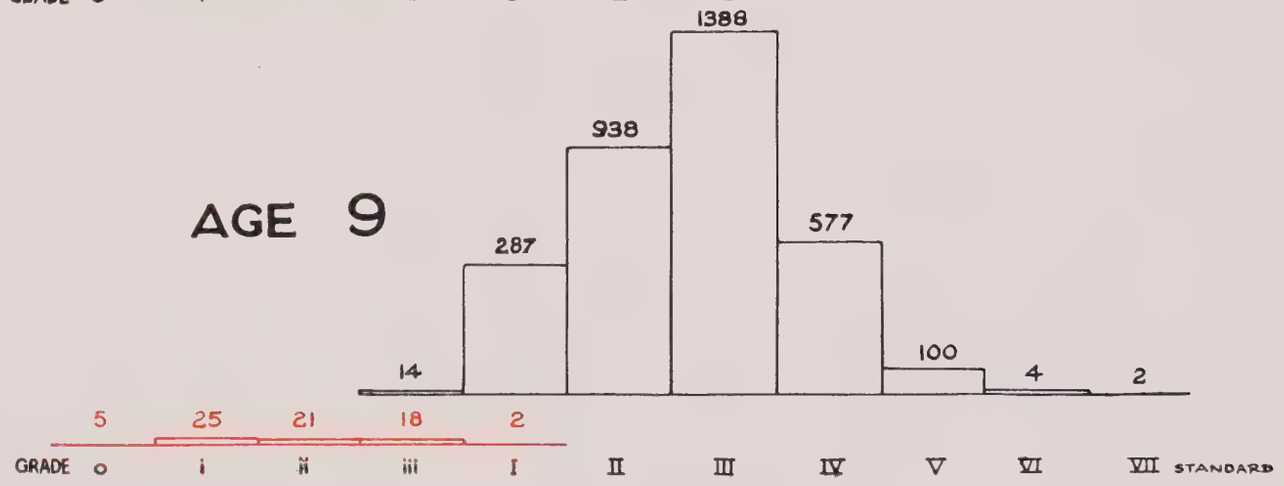
MENTALLY DEFECTIVE SCHOOLS 596
Representative by **RED** *Outline*

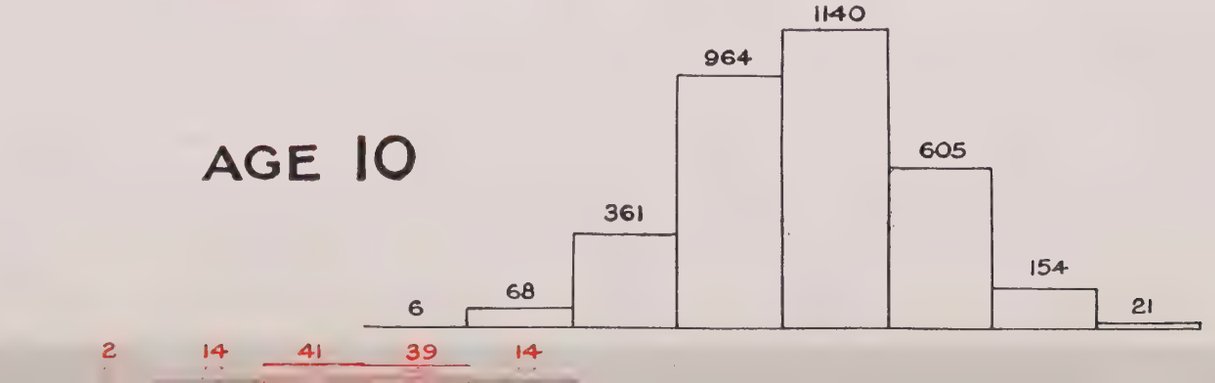


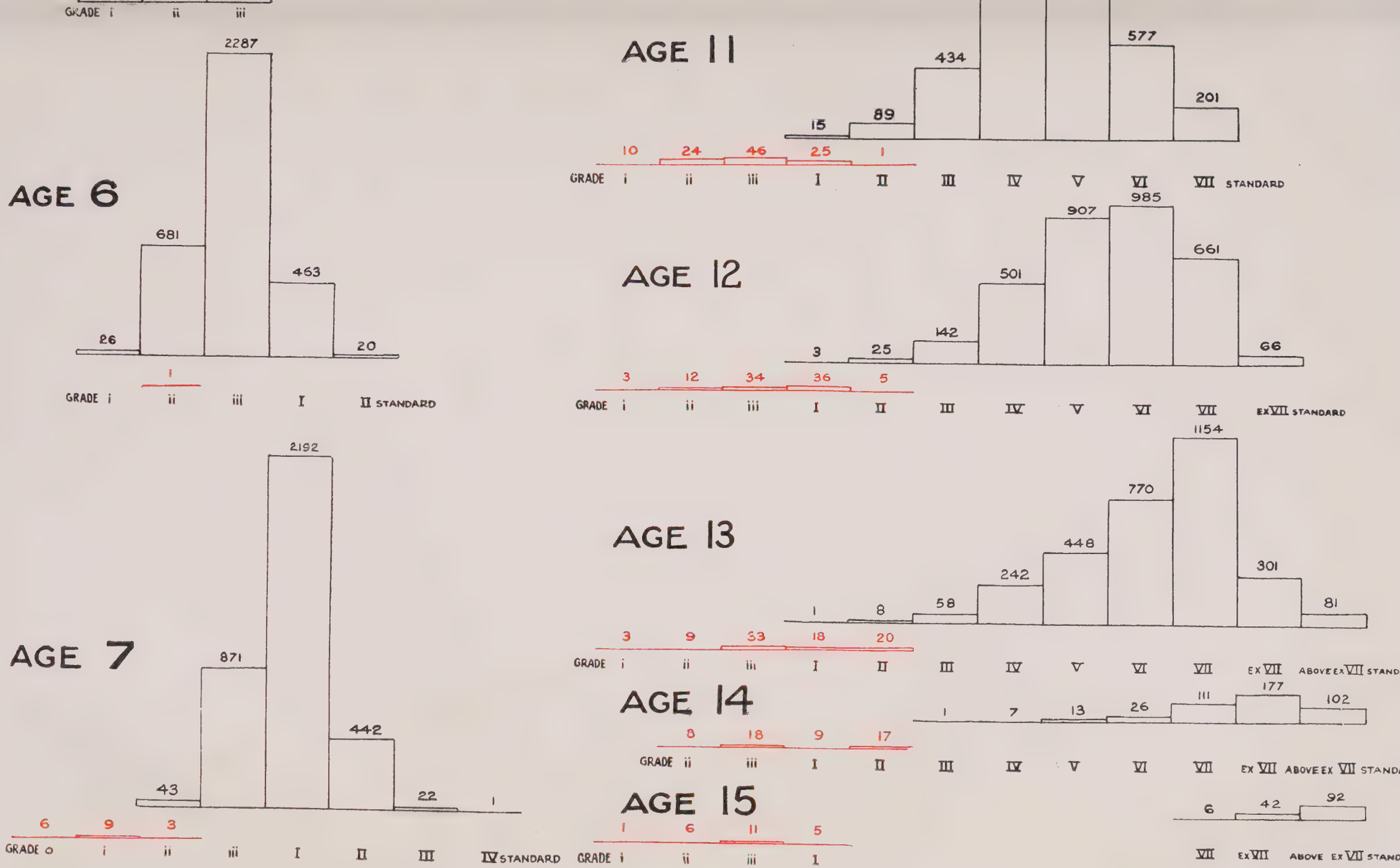











AGE 6
26
681
2287
463
20
1
GRADE i ii iii I II STANDARD
AGE 7
43
871
2192
442
22
1
6 9 3
GRADE 0 i ii iii I II III IV STANDARD
AGE 11
15
89
434
577
201
10 24 46 25 1
GRADE i ii iii I II III IV V VI VII STANDARD
AGE 12
3
25
142
501
907
985
661
66
3 12 34 36 5
GRADE i ii iii I II III IV V VI VII ExVII STANDARD
AGE 13
1
8
58
242
448
770
1154
301
81
3 9 33 18 20
GRADE i ii iii I II III IV V VI VII ExVII ABOVE ExVII STANDARD
AGE 14
1
7
13
26
111
177
102
8 18 9 17
GRADE ii iii I II III IV V VI VII ExVII ABOVE ExVII STANDARD
AGE 15
6
42
92
1 6 11 5
GRADE i ii iii 1 VII ExVII ABOVE ExVII STANDARD

limit of the scale here forms rigid zero-point: grade i. has been taken as the lowest class provided for the youngest or weakest children. A slight asymmetry in ages seven and eight is attributable to a similar cause: standard I. tends to act as a lower limit in assessing younger children in senior departments. But the appearance of these increased numbers is not entirely an artificial consequence of the classification upon which the estimates were based. The assignment of children to a certain class within the school organisation tends actually to assimilate their abilities into conformity with the prevalent type.

The conflicting asymmetry, then, at earlier and later ages, is by no means an inherent characteristic of the distribution of ability itself. It is due to the limits of the material and the scale. In the middle age-groups it vanishes. And here only do the individuals available provide a fair and unclipped sample: here only is the scale of classes sufficiently extensive to differentiate uniformly both among the abler and among the worse. For ages nine to eleven, ages in the middle of the school series, the frequency distributions approximate to an unmistakable type. The middle grade of ability has the highest frequency: adjacent grades on either side are nearly but not quite as common: extreme grades are comparatively rare: and there are about as many in the several grades above the middle as in the corresponding grades below. Further inspection suggests that, *in these age-groups, the distribution approximates to the "normal curve of error."* Such a distribution will arise when the variable measured is, like so many biological characteristics, the resultant of a large number of factors, operating in relative independence,—in a word of "chance." This approximation needs to be verified by exacter measurements and statistical tests worked out for all age-groups.[1] Were it confirmed, consequences of practical importance would ensue. When dealing with large numbers, it would be possible to predict the probable number of children, falling within or beyond specified limits of ability, with the same accuracy as we can foretell the ultimate proportion of "heads" in tossing coins, or the scattering of shots fired from a gun. This power of prediction in turn would entail corollaries for several administrative purposes—for the provision of classes for the backward, of schools and scholarships for the advanced, for the construction of schemes of marking, and for the selection of entrants for examinations, and for the internal organisation of the ordinary elementary school.

Correlation of Age and Class.

Children's educational attainments increase progressively with increasing age. It would, therefore, be of practical utility if we could compress the relation between age and class within a single formula, quantitative and precise. A plain relation is suggested by the frequencies in Table IX. The highest figures run obliquely from corner to corner like a diagonal of black squares across a chess board. The largest number in each successive age-group is to be found under each successive standard. The largest number in each successive standard is to be found against each successive year. The sole exceptions are found in age three, for whom no grade 0 is utilised, and in ages 14 and 15, small and selected groups, outnumbered in their standards by the preceding year. This one-one correspondence between age and class doubtless has originated in annual schemes of promotion and work. It suggests a simple formula for obtaining the age equivalent to a given class, or vice versa. *Age may be found approximately by adding* 6 *to the class, if in standards, or* 3 *if in grades. Class may be found approximately in standards by subtracting* 6 *from the age.* (Cf. columns 1 and 5 of Table X.)

(1) In age 10 such slight divergencies from an ideal normal distribution as actually occur might be expected in about 9 samples out of 10 ($\chi^2 = 2{\cdot}3$; $P = {\cdot}94$). But the data are too coarse to apply the usual criteria with any thoroughness.

TABLE X.—ORDINARY ELEMENTARY SCHOOLS.

Correspondence of Class and Age.

Table showing approximate correspondence of successive age-groups with successive classes, together with the average grade for each age, and the average age for each class, with their respective standard deviations.

Age.	Average class.		Standard deviation.	Corresponding class.	Average age.	Standard deviation.
Years.	Grade.	Standard.	Classes.		Years.	Years.
3—	(1·50)	(—1·50)	(0·06)	Grade 0	—	—
4—	1·64	—1·36	0·34	„ i.	4·69	0·59
5—	2·47	—0·53	0·55	„ ii.	5·69	0·46
6—	3·45	0·45	0·62	„ iii.	6·68	0·63
7—	—	1·37	0·63	Standard I.	7·86	0·82
8—	—	2·34	0·75	„ II.	8·95	0·97
9—	—	3·27	0·91	„ III.	10·03	1·07
10—	—	4·22	1·10	„ IV.	11·06	1·16
11—	—	5·14	1·17	„ V.	11·84	1·03
12—	—	6·00	1·18	„ VI.	12·47	0·87
13—	—	6·78	1·24	„ VII.	13·03	0·74
14—	—	8·20	(1·10)	„ Ex-VII.	13·83	0·71
15—	—	9·11	(0·57)	Above Ex-VII.	14·54	0·74
Average (all ages—unweighted)	—	3·34	0·79	Average (all grades—unweighted)	10·06	0·82
Average (ages 8— to 13— —unweighted)	—	4·62	1·06	Average (standards I. to VII.—unweighted)	11·23	0·95
All children ...	—	3·05	2·73	—	9·30	2·78

Regarded, however, from the standpoint of statistical correlation, the correspondence between age and class is clearly incomplete. The coefficient of correlation is ·948.[1] The rough rule above suggested implies a perfect correlation, and a coefficient of 1. As the increment corresponding to each successive year, it takes each class as an unbroken whole. Hence, with the lower ages and classes the average obtained will be too low; and with the higher, too high (compare columns 2 and 3 with 5 and column 1 with 6 in Table X.). The figure found will give the prevalent or "modal" class for each age-group, but not the exact arithmetic mean. For this we must use fractions. To determine the approximate mean age of a given class, and the approximate mean class for a given age, the more precise regression equations are as follows:—

$$\text{Age} = (\cdot 965 \times \text{Class} + 6\cdot 35) \text{ Years.}$$
$$\text{Class} = (\cdot 932 \times \text{Age} - 5\cdot 61) \text{ Standards.}$$

On the average, therefore, children advance, not by a whole standard, but by barely nineteen-twentieths of a standard for each successive year.

Problems of Norm and Unit.

The simple form of distribution, the simple relation between age and class, considerably assist the estimation of backwardness. But before we can estimate the numbers who are backward, the limits of backwardness must first be defined. This entails two enquiries. What level is to be

(1) The "probable error" of this coefficient is ·00057. The "correlation ratios" are ·944 (age on class) and ·949 (class on age). The regression line of age on class is manifestly curved. Owing to the standard deviations increasing at each successive age, the age-increments for each successive class at first increase; then, owing to the rapid reduction of numbers over age 14, they diminish. The regression of class on age is more nearly linear.

postulated as characteristic of the normal child at each age? What unit is to be employed in measuring deviations from this normal level?

To each question two answers may be made: a simple and a subtle. (1) For simplicity, the normal child may be assumed to advance to each succeeding class with each succeeding year; and backwardness may be measured as a delay of so many years—the difference between the class that should have been reached and the class that is actually attained. (2) For statistical precision, the exact average reached at every age may be computed, if necessary, in fractions of a class; and retardation may be measured from this average as so many times the standard deviation. Somewhat different results are given by the two methods thus available.

A.—PRELIMINARY ANALYSIS.

SCHOOL YEAR AS UNIT: INTACT CLASS AS NORM.

Definition of Normal Progress.

In the preliminary analysis, the classes will be left throughout as unbroken wholes. To be designated strictly normal a child will be required to enter standard I. at the age of seven, to advance annually to a new class, and eventually to reach standard VII. in his last school year. A child, therefore, of thirteen whose ability corresponds only to that of standard IV. will be termed backward by three years, since standard IV. should be reached at the age of ten. Throughout the description it must be remembered that class or grade or standard means a particular degree of mental capacity, not a teaching unit in a school organisation. Nevertheless, educational development year by year is thus made the analogue of school promotion class by class; and the tabulation thus remains in immediate relation with the practical classification adopted in the schools.

Definition of Backwardness and Deficiency.

This procedure has been familiarised by Binet and Simon, who have also suggested criteria for the degrees of retardation that may be considered grave.[1] As finally revised, their definition is as follows (*Mentally Defective Children*, 1914):

> "The retardation which determines a child as defective is two years under nine, and three years when he is past his ninth birthday" (p. 41). "A feeble-minded child is one who can communicate with his kind by speech or writing, but who shows a retardation of two or three years (according to the rules already indicated), in his school studies, this retardation not being due to insufficient or irregular attendance" (p. 78).

It will be observed that this definition, like the statutory definitions of the Acts of 1899 and 1913 so far as they refer to children, treats feeble-mindedness as characterised primarily by inability to profit by the instruction in the ordinary school.

Table of Retardation and Advancement.

Without further modification, therefore, the figures in the age-and-ability table (Table IX.) have been rearranged according to this plan—the plan adopted in the retardation-table for "defectives" (Table V.). The rearrangement is shown in Table XI. It gives the number of children in each class below or above the class they should be in, by one, two, three or more school years, or by none.

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(1) See also *Memorandum* I., pp. 11, 14.

TABLE XI.—ORDINARY

Distribution of Backwardness and

Table showing number of children at each age below, at, or above the "modal"

(Figures in brackets

Age.	Degree of Backwardness					
	– 6 years.	– 5 years.	– 4 years.	– 3 years.	– 2 years.	– 1 year.
3 —	...	...	...	...	...	...
4 —	...	...	...	...	...	...
5 —	...	...	...	...	...	544 (16·9)
6 —	...	...	...	...	26 (0·7)	681 (19·6)
7 —	...	...	...	...	43 (1·2)	871 (24·4)
8 —	...	...	...	2 (0·1)	87 (2·5)	1,075 (31·5)
9 —	...	...	...	14 (0·4)	287 (8·7)	938 (28·3)
10 —	...	...	6 (0·2)	68 (2·1)	361 (10·9)	964 (29·0)
11 —	...	...	15 (0·5)	89 (2·7)	434 (13·3)	942 (29·0)
12 —	...	3 (0·1)	25 (0·8)	142 (4·3)	501 (15·2)	907 (27·6)
13 —	1 (0·0)	8 (0·3)	58 (1·9)	242 (7·9)	448 (14·6)	770 (25·1)
14 —	...	1 (0·2)	7 (1·6)	13 (3·0)	26 (6·0)	111 (25·4)
15 —	...	...	...	...	6 (4·3)	42 (30·0)
Total number of children backward or advanced by the number of years indicated.	1 (0·003)	12 (0·037)	111 (0·32)	570 (1·79)	2 219 (6·94)	7,845 (24·54)
	(33·66) Below Age.					

ELEMENTARY SCHOOLS.

Advancement in Educational Ability.

r prevalent class for their age by the number of years indicated.

ive percentages.)

r Advancement.					Total for each age.
0	+ 1 year.	+ 2 years.	+ 3 years.	+ 4 years.	
...	235 (99·6)	1 (0·4)	...	...	236 (100)
1,072 (86·5)	167 (13·4)	1 (0·1)	...	...	1,240 (100)
2,224 (69·1)	451 (14·0)	...	...	...	3,219 (100)
2,287 (65·8)	463 (13·3)	20 (0·6)	...	...	3,477 (100)
2,192 (61·4)	442 (12·4)	22 (0·6)	1 (0·0)	...	3,571 (100)
1,614 (47·3)	558 (16·4)	74 (2·2)	1 (0·0)	...	3,411 (100)
1,388 (41·9)	577 (17·4)	100 (3·0)	4 (0·2)	2 (0·1)	3,310 (100)
1,140 (34·3)	605 (18·2)	154 (4·7)	21 (0·6)	...	3,319 (100)
994 (30·6)	577 (17·7)	201 (6·2)	...	...	3,252 (100)
985 (29·9)	661 (20·1)	66 (2·0)	...	...	3,290 (100)
1,154 (37·7)	301 (9·8)	81 (2·7)	...	...	3,063 (100)
177 (40·5)	102 (23·3)	...	...	...	437 (100)
92 (65·7)	...	...	...	...	140 (100)
15.319 (47·92)	5,139 (16·08)	720 (2·25)	27 (0·085)	2 (0·006)	31,965 (100)
(47·92) At Age.	(18·42) Above Age.				

Apparent Prevalence of Backwardness.

In this table the last two lines, giving totals and percentages, yield a striking summary of the distribution of backwardness and advancement among the children of the borough. Figure 4 shows the frequencies diagrammatically.

Of the children over nine and under fifteen, attending the ordinary schools of the borough, *nearly seven hundred appear backward by three years or more:* to be precise, 692, or about 4·2 per cent. These numbers would more than re-fill all the special (M.D.) schools of the borough notwithstanding that their accommodation is in proportion nearly twice as great as that of other boroughs (626 for 1915-16), and, of course, also contemplates children under nine and over fourteen.

If we extend the lower age limit from nine to five, and if we further include those backward by two years, the apparent number rises to nearly three thousand, or *about one-tenth of all between five and fifteen:* the exact figures are 2,907 individuals, or 9·53 per cent. In addition, 25·6 per cent., or more than a quarter, appear a year behind their actual age. *Barely one-half, 46·4 per cent., are assigned to a grade or standard assumed as normal for their age.*

Sex-Differences.

In Tables XII. and XIII. the percentages of children, classed below, at or above their age, are shown separately for the Boys' and Girls' departments and for Council and Non-provided schools. Owing to their small and irregular numbers, children under eight and over fourteen are not included.

TABLE XII.—ORDINARY ELEMENTARY SCHOOLS.

Distribution of Educational Ability in Boys' and Girls' Departments in Council and Non-provided Schools.[1]

Percentages of children (aged 8— to 13—) in classes below, level with, or above those corresponding with their age.

	Below age.						At age.	Above age.			
Years	−6	−5	−4	−3	−2	−1	0	+1	+2	+3	+4
Council Schools, Boys' ...	0·01	0·07	0·7	3·1	11·6	29·9	35·9	15·4	3·2	0·12	0·00
			45·4				35·9		18·7		
Council Schools, Girls' ...	0·00	0·03	0·3	2·5	9·8	29·0	39·1	16·6	2·5	0·16	0·01
			41·6				39·1		19·3		
Non-provided Schools, Boys'	0·00	0·05	0·2	3·6	12·3	31·9	37·4	12·7	1·8	0·00	0·05
			48·1				37·4		14·5		
Non-provided Schools, Girls'	0·00	0·12	1·1	4·1	15·4	33·0	35·0	9·4	1·6	0·27	0·00
			53·7				35·0		11·3		

(1) In comparing Council and Non-provided schools, the figures for Central schools, included in Table VII., have been omitted from the figures for Council schools in Tables XII. and XIII. and Figure 4.

(To face p. 29.)

FIGURE 4.

FREQUENCY
OF THE VARIOUS DEGREES OF
BACKWARDNESS
AND
ADVANCEMENT
AMONG CHILDREN OF ORDINARY ELEMENTARY SCHOOLS IN A SINGLE BOROUGH

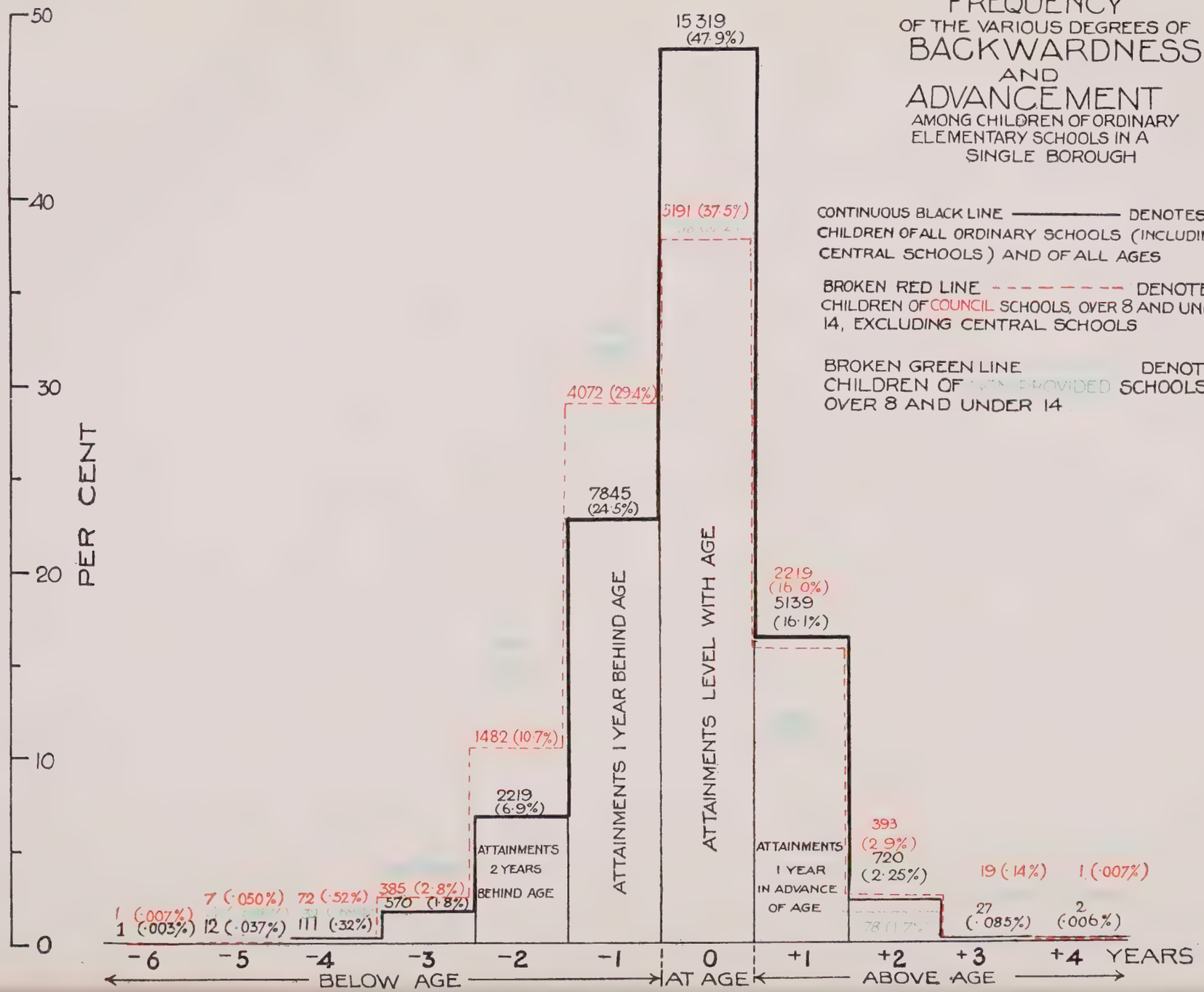

TABLE XIII.—ORDINARY ELEMENTARY SCHOOLS.

Distribution of Educational Ability in Council and Non-provided Schools and in Boys' and Girls' Departments.[1]

Percentages of children (aged 8— to 13—) in classes below, level with, or above those corresponding with their age.

	Below age.						At age	Above age.			
Years	−6	−5	−4	−3	−2	−1	0	+1	+2	+3	+4
Council Schools	0·007	0·05	0·5	2·8	10·7	29·4	37·5	16·0	2·9	0·14	0·007
			43·5				37·5		19·0		
Non-provided Schools ...	0·00	0·09	0·7	3·7	14·2	31·6	37·2	10·6	1·7	0·15	0·02
			50·3				37·2		12·5		
Boys' Departments	0·01	0·06	0·6	3·2	11·8	30·3	36·3	14·8	2·8	0·09	0·01
			46·0				36·3		17·7		
Girls' Departments	0·00	0·05	0·5	2·9	11·2	30·0	38·0	14·8	2·3	0·19	0·01
			44·7				38·0		17·3		

The differences between the boys' and girls' departments are slight and conflicting. In Council schools, retardation is exhibited more frequently among the boys. This is in conformity with the statement of Binet and Simon; they, however, only investigated certain selected schools. In Non-provided schools, it is the girls who show the more retardation. The figures, therefore, appear influenced by the type of school.

Differences between Council and Non-provided Schools.

Between Council and Non-provided schools the differences are consistent and marked. In Council schools there are only 43·5 per cent. below the level of their age. In Non-provided schools there are 50·3 per cent., practically one-half. The discrepancy is greatest in the case of the girls. Here the figures are 41·6 per cent. for Council schools, and 53·7 per cent. for Non-provided schools a difference of over 12 per cent. Of the 743 girls aged 12 and 13 in the Non-provided schools, 28 are actually backward by four years or more; that is, a proportion of about one in twenty-seven. The difference in distribution for the two types of schools is shown diagrammatically in Figure 4.

Apparent Form of Total Distribution.

When all age-groups are thrown together, the distribution of backwardness and retardation is found to conform to no simple curve. Its form is both asymmetrical and peaked. The possible explanations of these peculiarities call for a brief and somewhat technical discussion.

(1) In comparing Council and Non-Provided schools, the figures for Central schools, included in Table VII., have been omitted from the figures for Council schools in Tables XII. and XIII. and Figure 4.

Distribution "Skewed" by Choice of Norm.

The asymmetry, uncritically accepted, would lend colour to a contention familiar in individual psychology, namely, that human ability is distributed unequally—inferior variations being greater and commoner than superior. The backward children appear to be nearly twice as numerous as the advanced. Below the class assigned to their age, there are, in all, over ten thousand children (10,758); above there are barely six thousand (5,888).

The disproportion may be explained apart from psychological hypotheses. The data are imperfect: the analysis too coarse.

As we have seen, the brighter children of the higher ages are but partially represented. This is again evident in the body of Table XI. In the pyramid of figures, near the bottom right-hand corner, a large gap has been excised.

This initial asymmetry is enhanced by the simple classification used. We have worked by entire standards, taking each successive standard as corresponding to each successive age. In classifying each age-group, a central or zero class has been chosen whose mid-value is higher than the exact arithmetic mean. For example, more children aged 13—appear in standard VII. than in any other class. Hence, we have taken standard VII. as the normal level for thirteen, the highest class for the oldest age; and have designated all in standard VI. or below as backward. But ability does not develop in sudden and complete instalments. Like the line of time, clipped conventionally into discrete years, it really forms a continuous scale. Our units or "classes" may, therefore, be regarded as divisible at any point into fractions. With this treatment the exact average or mean no longer coincides with the class chosen as a whole to represent the prevalent level or "mode." It falls below. The mean level for age thirteen now proves to be at St. 6·78, *i.e.*, near the top of that section of ability described as standard VI. For purposes of organisation, perhaps, all the thirteens estimated as of standard VI. ability may roughly be described as a year behind their class; but for purposes of psychological measurement the undivided year appreciably exaggerates the amount of their retardation.[1]

Accordingly, before accepting the final distribution as markedly asymmetrical, we must re-classify our data about a more exactly calculated norm.

Distribution "Peaked" by Choice of Unit.

The distribution of the retardation-table differs from the normal in being not only skewed, but also peaked. This can be seen by comparing the contour shown in Figure 4 with that of the normal distribution shown in Figure 7. The central column is stacked up like a factory chimney among the adjacent blocks, instead of merely rounding off the summit of a chance-thrown heap. Not only are the numbers unequally distributed on either side of the middle class, but in the middle class itself the numbers are far too high. Such a distribution is obtained by mixing two or more groups scattered differently about their average. Ages three and four, where few fall outside the normal classes, have been superposed upon ages twelve and thirteen, where the individuals vary up and down the entire school scale. This generates a distribution shaped like an inverted "T." The addition of the other ages fill up the angles between the three limbs, but not completely.

If we allow for the gaps left by the absent brighter children of older age, the range of variation will be seen steadily to increase from age to age. It is this which produces the pyramidal arrangement of Table XI. As with the "defectives," the divergence of a single year appears to signify far less at the higher ages than at the lower. Hence, any comparable measure of backwardness or advancement must not be couched in terms of actual years; with increasing age the figure obtained in years must be progressively reduced; and the amount of reduction will depend inversely upon the average range of variation in each successive age-group.

Accordingly, before our data are reclassified, we must find for each age, not only a more exact central value, but also a unit of scale more nearly uniform.

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(1) In a group that is slightly skewed, the choice of the "mode" as "norm" necessarily enhances the apparent asymmetry, that of the "mean" reduces it, that of the "median" would, by definition, abolish it altogether.

Figure 5.

DIAGRAM
TO SHOW
INCREASE OF APPARENT VARIABILITY
WITH
INCREASE OF AGE

RED LINE REPRESENTS THE EQUATION:—
STANDARD DEVIATION $= \frac{1}{10}$ (AGE$-\frac{1}{2}$)

(To face p. 31.)

The Standard Deviation, and its Correlation with Age.

The extent to which children of a given age vary up and down the scholastic scale may be measured in several ways. The simplest would be to take the individual deviations above or below the average for the group, ignore the direction of the deviation or "sign," and calculate their arithmetic mean. For statistical purposes, it is better first to square the deviations, and then to take the square root of their mean. This more elaborate calculation automatically eliminates the difference of "sign," and gives greater weight to extreme deviations. The measure thus obtained for scatter, dispersion, variability, or spread, within each group, is its Root-Mean-Square (or "Standard") Deviation.

The standard deviations for the several ages and grades are given in Table X. Except where the age-groups are small in number or selected in kind, the increase with age is fairly regular. This tendency is illustrated in Figure 5. A close inspection of the points there plotted suggests that the standard deviation increases at a rate which is slightly more rapid in the earlier years,—from age 7, and perhaps before, as far as age 10,—and at a gradually decreasing rate thereafter. But, for practical purposes, age and variability may be taken as directly proportional. If we assume that the standard deviation is one-tenth of the age last birthday, we obtain for the diagram a straight line, which, between the ages of four and thirteen, fits the observed results sufficiently well. Within the limits of the standard deviation, measured on both sides of the mean level, 68·3 per cent. of the whole group will be included. Thus, about two-thirds of the group aged ten will lie between the average level of the nines and the average level of the elevens. One-sixth will lie below, one-sixth above. In this sense, therefore, we may say that, *in educational ability normal children tend to vary above and below the average level for their age as follows:—*

at the age of 10, *by at least* 1 *year,*
at the age of 5, *by just* ·5 (*half*) *of a year,*
at the age of 15, *in all probability, by nearly* 1·5 (*one and a half*) *years, and throughout, by about one-tenth of their age.*

Comparison of Physical and Mental Variability.

For confirmation it would be most suggestive to compare figures for physical variability. Unfortunately reports are usually content with averages. Seldom do they provide measures of the range of deviation. In an appendix, therefore, I have given rough figures for height and weight (Tables XXX. and XXXI.). It will be seen that standard deviations steadily increase with increasing age; even when reduced to a percentage of the age-average, variability tends slightly to increase. Here, therefore, we appear to have a general law. Measured by the absolute units of the original measurements, *the differences between individuals tend to grow larger as the individuals themselves grow older.* There is a practical corollary. *The increased differentiation manifested at higher ages demands a corresponding increase of differentiation in the education then provided.*

For height, as for educational ability, the standard deviation about the middle of the school career is roughly equal to the annual increment—perhaps a little over. For weight it is equivalent to an increase of about $1\frac{1}{4}$ years. So far as these limited measurements go, *educational variability appears to be of much the same order as physical variability.* Now there is reason to believe that in higher mental capacities individuals differ far more than in height or weight. In tests of intelligence consecutive age-groups overlap considerably. The standard deviation is about $1\frac{1}{2}$ mental years. We may, therefore, surmise that education makes too much for uniformity. It may force up the backward. But it fails to push on the brightest to the utmost of their potentialities. Further enquiry, however, is needed to establish this conjecture.

B.—RE-ANALYSIS.

MEAN AS NORM: STANDARD DEVIATION FOR EACH AGE AS UNIT.

Re-calculation of Frequencies for Total Retardation and Advancement.

We have now an equivalent unit in terms of which advancement, backwardness and deficiency may comparably be measured at different ages. This unit must be substituted for the "mental year" or intact "class" before calculating the total figures for the new retardation-tables.

Upon this basis, all the school-children, both "normal" and "defective," have been reclassified. Children over eight and under fourteen alone have been retained. Below and above this range, as we have seen, the age-groups are somewhat selected, and the estimates somewhat distorted. For each age-group the original distribution has been smoothed. The scale has been redivided, with the fractional mean of the age-group as zero, and the standard deviation of the age-group as unit. The original classes have been split by the limits thus interposed; the frequencies have been apportioned anew among the sections into which ability has been thus marked off; and by reference to the original estimates and the results of the experimental tests, the redistribution has been checked. The ultimate results are shown in Table XIV. A similar redistribution for the children of the special (M.D.) schools is given in Table XV.

TABLE XIV.—ORDINARY ELEMENTARY SCHOOLS. (Ages 8- to 13- only).

Distribution of Educational Ability with Standard Deviation as Unit of Classification.

Table showing number of children at each age deviating from the average for their age by 0, 1, 2, or more times the Standard Deviation of the whole age-group. (Note.—Standard Deviation of any age-group when measured in terms of mental years approximately equals one-tenth of the age.)

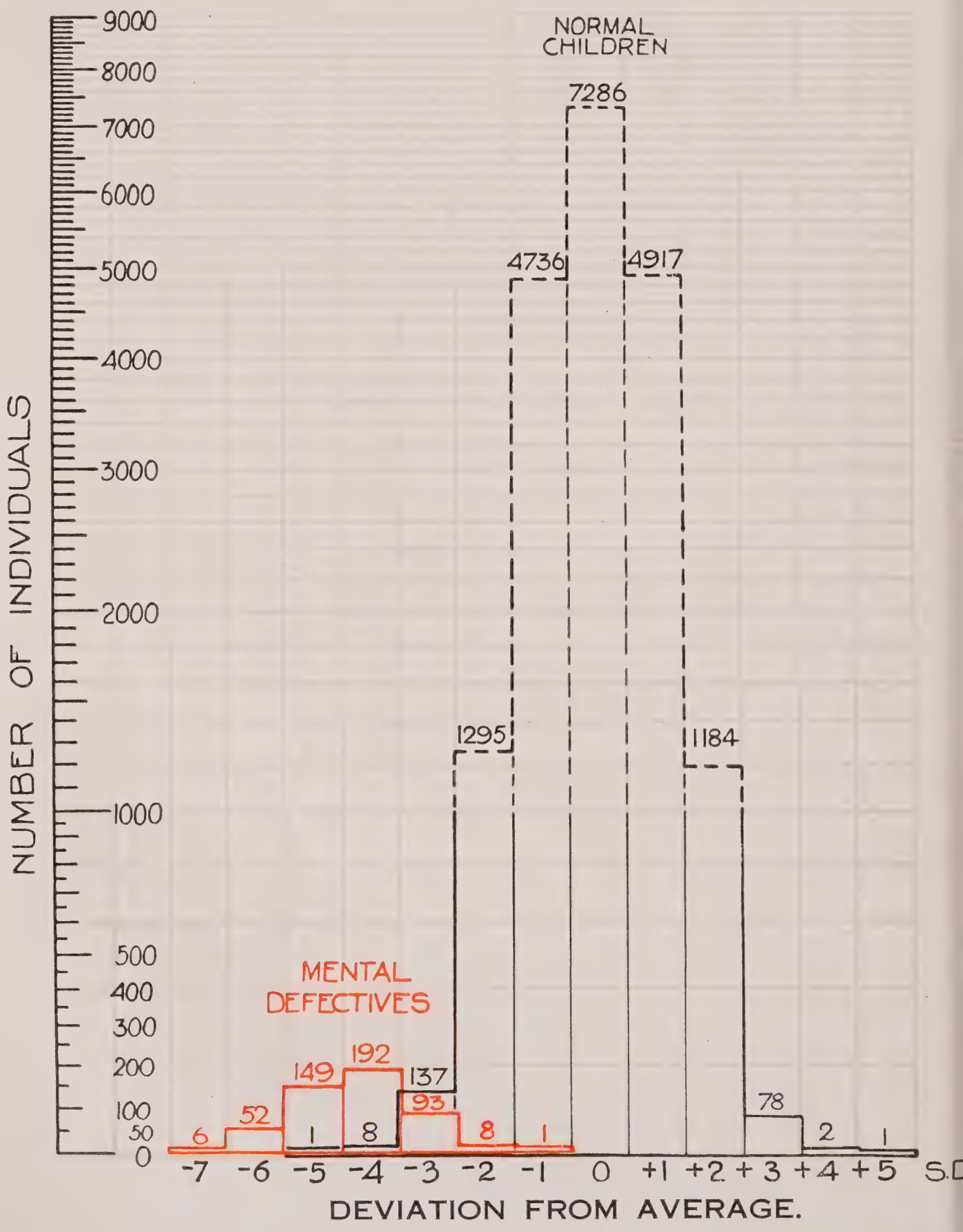
Age.	Deviation.											Total.
	− 5 S.D.	− 4 S.D.	− 3 S.D.	− 2 S.D	− 1 S.D.	0 S.D.	+ 1 S.D.	+ 2 S.D.	+ 3 S.D.	+ 4 S.D.	+ 5 S.D.	
8 — ...	—	1	21	170	855	1,344	755	236	28	1	—	3,411
9 — ...	—	1	11	239	776	1,288	737	240	16	1	1	3,310
10 — ...	—	2	25	188	848	1,196	827	204	29	—	—	3,319
11 — ...	—	1	24	210	818	1,162	842	195	—	—	—	3,252
12 — ...	—	2	35	225	794	1,161	893	177	3	—	—	3,290
13 — ...	1	1	21	263	645	1,135	863	132	2	—	—	3,063
Total for each degree of deviation.	1	8	137	1,295	4,736	7,286	4,917	1,184	78	2	1	19,645
Numbers expected with a "normal" distribution (decimals omitted).	0	5	117	1,190	4,749	7,523	4,749	1,190	117	5	0	19,645
Percentage (observed).	·0051	·041	·70	6·60	24·11	37·08	25·03	6·03	·39	·010	·0051	100
Percentage (normal).	·0003	·023	·60	6·06	24·17	38·29	24·17	6·06	·60	·023	·0003	100

Figure 6.

DISTRIBUTION
ACCORDING TO
EDUCATIONAL ATTAINMENTS
OF ALL
NORMAL AND MENTALLY DEFECTIVE
CHILDREN, AGED 8 TO 13
ATTENDING ELEMENTARY SCHOOLS WITHIN A SINGLE BOROUGH

BLACK COLUMNS REPRESENT 19,645 NORMALS
RED COLUMNS REPRESENT 501 DEFECTIVES

UNIT OF BASE LINE IS STANDARD DEVIATION OF EACH AGE,= $\frac{1}{10}$ OF AGE
OR 1 YEAR AT AGE 10.



(To face p. 33.)

TABLE XV.—SPECIAL (M.D.) SCHOOLS.
(Ages 8- to 13- only).

Distribution of Educational Ability with Standard Deviation as Unit of Classification.

Table showing number of defectives at each age deviating from the average level of normals of corresponding age by 0, 1, 2, or more times the Standard Deviation of the "normal" age-group. (Note.—Standard Deviation of any age-group when measured in terms of mental years approximately equals one-tenth of the age.)

Age.	Deviation.							Total for each age.
	−7 S.D.	−6 S.D.	−5 S.D.	−4 S.D.	−3 S.D.	−2 S.D.	−1 S.D.	
8—	2	11	15	8	4	1	—	41
9—	2	10	22	19	16	1	1	71
10—	—	5	24	47	29	5	—	110
11—	—	9	19	53	24	1	—	106
12—	1	7	35	39	8	—	—	90
13—	1	10	34	26	12	—	—	83
Total for each degree of deviation	6	52	149	192	93	8	1	501
Numbers expected for each degree of deviation in a total population normally distributed.	0·12			7·9	206·9	2090·3	8336·9	—

(N.B.—The total population is assumed to have the same variability as the "normals" of the borough investigated, and to number 34,493,—the proportion of "defectives" to total population being made the same as for all London, viz., about 1·45 per cent.)

Much of the apparent asymmetry has now vanished from the normal age-groups; although it is still discernible in age thirteen and perhaps age eight. Further, the figures for each section now extend over a range which is similar for every age. For measures of inborn ability this seems correct. Inborn differences between individuals must, by definition, be considered to remain, in spite of growth, approximately constant. Apart from illness, or other special cause, a child born normal does not become defective. Nor can a defective grow up into a normal. But from the standpoint of practical administration, a deviation, which is insignificant in early years, may well develop graver practical consequences later on. Children classed together as infants may be unable to associate for joint work when nearly adult.[1]

For mere measurement, then, the units employed at different ages are now equivalent. Hence, the figures for each degree of deviation may legitimately be added. The resultant totals indicate the final form of distribution. It is given diagrammatically in Figure 6. To show columns representing 50 to 190 children upon the same diagram as 4,000 to 7,000, the vertical scale has been condensed progressively towards its upper end. This has been done by making the heights of the columns proportional to the logarithms of the numbers represented instead of to the numbers themselves. The frequencies for the "defectives," similarly re-calculated, are shown in red.

(1) We are here again in contact with the theoretical distinction between ability and attainments. Roughly, we might define ability as a capacity purely innate, and, therefore, constant; while attainments accumulate progressively with age. The justification for identifying the two in preliminary enquiries lies in the fact that, in the concrete, effective ability inevitably depends upon acquired attainments, and, even in the abstract, ability must largely be regarded as power to acquire, and, therefore, be measured through attainments. But the whole question is further complicated by the probable existence of individual differences in innate potentialities for postnatal growth, in the sense of intrinsic and spontaneous mental development apart from all acquisition of knowledge or skill.

This diagram, then, yields perhaps the best picture of the distribution of educational ability among ordinary and defective children within a single borough.

Final Form of Distribution.

Thus readjusted, the distribution approximates more closely to the "normal curve." The similarity can be seen by comparing the observed totals given in Table XIV. with the numbers beneath, calculated upon the hypothesis of normal distribution.[1] The form of distribution is less skew and very much flatter than before. From 2 S.D. onwards, the higher groups still contain rather fewer, the lower rather more, than we might expect by chance. But the central section, 0 S.D., contains appreciably less; the peak has gone. Some asymmetry, due to the original data, necessarily remains, and the combination of slightly asymmetrical groups would naturally yield a flatter final form. Apart from these disturbances, attributable chiefly, it would seem, to observational error, the results are consistent with the hypothesis that, like physical stature and many other anthropological features, but unlike wealth or land, *educational ability is normally or nearly normally distributed among the population.*[2] The practical importance of this has already been remarked in discussing the apparent normality of the central age-groups (p. 23). A precise test, however, for normality is precluded by the coarse grouping of our initial estimates; their whole range covered only a dozen grades and standards. Nor can we prove the intervals between the grades and standards to be strictly equal throughout or the scale uniform, as we have assumed. Final verification, therefore, must await the results of minuter modes of measurement.

Comparison of 'Normals' and 'Defectives.'

Between the "normals" and the "defectives" there is a distinct overlap. The overlap appears far smaller in educational ability than in general intelligence.[3] Yet the one group still merges continuously into the other. There is no gap.

The apparent amount of overlap is affected by at least two causes. First, the proportion of defectives to normals is unusually large. In a diagram given by the Medical Officer, showing the geographical distribution of mentally defective children throughout London,[4] the maximum proportion of "defectives" is found in the northern area of the borough here studied, together with two or three smaller and exceptional districts. For the ages with which we are working, the percentage in the borough surveyed is nearly twice (1·73 times) as large as the average for the other boroughs. But the special schools of the borough are not recruited solely within the borough boundaries. If we assume that the percentage of defectives is the same as for all London—namely, within these ages, 1·45 per cent.—then the total population from which they have been selected must number not 19,645, but 33,493. If we suppose this population to have the same variability as the ordinary school children here surveyed, and to be distributed

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(1) On attempting to test "goodness of fit" in the usual manner, χ^2 proves to be 43·1, which for 9 groups gives P = ·000,003, *i.e.*, the observed distribution might be expected once in 300,000 trials, if the sample were taken from a population strictly governed by the law of the "normal" curve. But with the large sample, rough estimates, and coarse grouping here employed the criterion is hardly applicable.

(2) In a preliminary non-technical account it seems more important to emphasise the approximation to normality. In a more technical discussion emphasis would perhaps be thrown rather upon the fact that this approximation was by no means perfect. Reasons might be adduced for expecting that, in fact, the distribution of ability is probably *not* quite normal—especially among growing children, and the lower or backward tail is probably the longer. In any case, it should be remembered that the "normal" curve is but one abstract form of an infinite series of curves. It provides a convenient generalisation for further deductions. But there is no grand *a priori* reason why we should expect our data precisely to conform with it.

(3) Compare *Report by the Council's Psychologist*, February, 1915, Diagram, p. 5.

(4) *Annual Report of the Council*, 1913, vol. III., *Public Health*, p. 216, Diagram K.

"normally," then, instead of only 1,441 "normals" below −1·5 S.D., we should have 2,302 (the theoretical frequencies for such a normal tail are given in Table XV.). But in the classes beyond −3 S.D. the high number of defectives could not possibly be obtained on these assumptions. Among these, therefore, we may surmise that a number of truly abnormal or pathological cases are intermixed. The variability, however, of the ordinary children is undoubtedly too small. Many of the brightest children we have seen are not included. Many of the backward are probably displaced too near to the average for their age. Hence, the statistical evidence for the existence of a distinct species of pathological "defectives," unobtainable by normal variation of a vast normal group, and distinguishable from extreme cases of mere backwardness, remains inconclusive. The experimental study of individual children nevertheless corroborates such a hypothesis.

Apparent Line of Demarcation between the Ordinary and Defective Child.

The distribution of the "defectives" is not symmetrical, but declines more rapidly upon the higher side of their average between −4 and −2 S.D. If, however, in selecting children as "defectives," we were sharply cutting off the tail-end of a normal distribution, we should expect the fall towards the line of cleavage to be even more abrupt that it is.

The general line between normals and defectives seems to have been drawn by those who nominate or admit candidates for special (M.D.) schools within this borough at about −3 S.D. That is to say, *a child who is retarded by more than three-tenths of his age is regarded as qualified for a special school.* In this region overlapping is greatest. Between −2·5 S.D. and −3·5 S.D. fall 137 normals and 93 defectives.

An attempt is in progress to follow up the various individuals detected as the source of this overlapping. The nine children in ordinary schools who are backward by four- or five-tenths of their age, might well have been admitted at an earlier age to a special school. The nine defectives who are backward by only one- or two-tenths of their age might well be returned to the ordinary schools, except where admitted for moral rather than for educational or intellectual defect. The mixed group who are backward by 25 to 35 per cent. of their age are border-line cases, some of whom have been sent to special schools, and the rest left in ordinary schools, in virtue of the various ways in which their condition was interpreted or overlooked.

It is satisfactory to find that, in the borough under review, the line of division fluctuates for the most part within a single year, especially when it is remembered that educational deficiency is not the sole criterion. This reduction has partly been achieved during the past eighteen months. (Compare my earlier Reports to the Special Schools Sub-Committee on these same schools.) Over London, generally, however, standards still waver enormously from one school to another.

Line of Demarcation between the Backward and the Unretarded.

The lower limit for the backward child in the ordinary school may be assumed to coincide with the line of demarcation for defectives—namely, about −3 S.D. The upper limit must be a more arbitrary affair. On either side of the three middle columns of Figure 6, that is, beyond + or −1·5 S.D., the frequencies suddenly drop. In the middle of the school career, at the ages of nine to twelve, these limits correspond to a range of about three school-years. Within them fall nearly seven-eighths (86·6 per cent.) of a "normally" distributed age-group. Below will fall but little more than one-sixteenth; or, allowing for asymmetry and over-rating, perhaps one-tenth. The usual organisation of the ordinary school may well be expected

to cater for the central seven-eighths. A range of three consecutive classes will, as a rule, include them. The lower tenth, however, will be associating with children very unequal in physical and moral development, for with the oldest children a deviation of −2 S.D. will mean a backwardness of nearly three years. Here, then, at −1·5 S.D. we may conveniently fix the upper limit for backward children needing accommodation in a special class. *Accordingly, by "backward" may be understood children who, though not defective, are yet unable, about the middle of their school career, to do the work even of a class below their age; or, more precisely, children who are retarded by* 15 *to* 30 *per cent. of their age, and, therefore, deviate below the normal by about twice the average (or "standard") deviation of individuals of the same age-group.*

To the − 2 S.D. section 1,295 ordinary children are assigned: these are backward by two-tenths of their age. If we include the section below, the figure rises to nearly fifteen hundred. This constitutes a much smaller estimate than that obtained from the preliminary analysis. The alteration is due to the enlargement of the unit of measurement, and the lowering of the average level, chiefly affecting the older years. The new figure is doubtless an underestimate. First, the brightest children over ten have not been included in calculating the average, having left for higher schools. Hence, the averages for older ages are too low. Secondly, older children who are backward, have been assigned to classes nearer to the average level than their ability alone would warrant. Allowance for this in teachers' estimates has been made with caution; but its influence must still remain. Finally, for older children the actual number of years or classes by which they are retarded should perhaps have greater weight in school organisation than the reduced psychological measure of their mental deviation. A backwardness of four years at fourteen has been treated theoretically as no graver than a backwardness of two years at seven. But it is far more serious to place the child of fourteen in standard IV. side by side with children of ten or even eight and seven, than to associate a backward child of seven with children only five.

On further investigation as to how many of those omitted by the re-analysis should be added in view of these considerations, the estimate rises to 2,018. *In round numbers, then, over two thousand children in this borough —at the very least,* 10 *per cent. of the senior school population—are definitely backward.*

The returns of school medical officers in various parts of the country often include estimates as to incidence of backwardness. In those available, the percentages in towns alone range from 0·8 at Leeds to 14·6 at Sunderland. But such discrepant figures can have little value. It is evident that at present there is no generally recognised standard of backwardness.

Causes of Backwardness (Tentative Suggestions only).

It is interesting to enquire why the most backward of all have escaped recommendation for special instruction. A generous explanation is that their educational backwardness has been assigned to extraneous causes, such as irregular attendance, rather than to defective intelligence. Most frequently the causes have never been analysed: and when analysed, the weight assigned to them depends purely upon unverified generalization and personal views. In following up the various individuals an attempt is being made to trace the chief factors to which backwardness may be assigned. So far as it has advanced, the investigation does not show any constant differences in conditions between the more backward children in the ordinary

schools and the least backward cases in the schools for the mentally defective. The chief result that hitherto has emerged is that *backwardness is a highly complex condition, attributable to a variety, and usually to a plurality, of converging causes.* The following is a very rough classification of the chief factors hitherto revealed.

Figures are given to indicate the percentage of cases which has been attributed primarily or predominantly to each factor. The numbers, however, are based upon the investigation of but a very small sample. No allowance is made for the multiplicity of causes usually discoverable in each case. No attempt is made to estimate the relative frequencies of the numerous contributory or subordinate factors, commonly associated with those reputed to be the primary cause.

CAUSES OF EDUCATIONAL BACKWARDNESS.

A.—Extraneous or Non-mental Factors: (the backwardness being secondary or acquired): ... ... 39 per cent.

1. Irregular Attendance (late admission, frequent absence, or prolonged absence): (*a*) due to ill-health, exclusion for uncleanliness, infectious ailments, etc. ... ... 5 per cent.
2. Irregular Attendance (*b*) due to negligence, migration, etc. ... ... 6 per cent.
3. Inefficient Teaching in earlier years: discontinuity between infants' and senior departments: change of teaching methods with change of school ... ... 4 per cent.
4. General Physical Defect: (general constitutional debility; lowered vitality, due to malnutrition, loss of sleep, excessive fatigue from out-of-school employment,—all commonly associated with bad social circumstances) ... ... 10 per cent.
5. Special Physical Defect: (*a*) tonsils, adenoids, etc. ... 3 per cent.
6. Special Physical Defect: (*b*) sensory,—deafness, bad eyesight; motor,—paralysis, incoordination, left-handedness; articulative,—retarded or imperfect speech development ... ... 4 per cent.
7. Defect of Character ("laziness," "inattention," "disobedience," "temper," "lack of interest," "lack of will-power," etc.,—usually due both to inborn instability and to subsequent life-history, but in varying proportions): (*a*) chiefly traceable to repressed emotional experiences (*e.g.*, to fright, resentment against unintentional or fancied injustice from parent or from teacher) ... 7 per cent.

B.—Intrinsic or Mental Factors: (the backwardness being apparently primary or innate): ... ... 61 per cent. [not including B. 2.]

1. Weak General Ability, *i.e.*, inferiority apparently inborn, of all-round mental efficiency, often hereditary, but not sufficiently pronounced to be denominated "mental deficiency" ... ... 11 per cent.

2. Weak Specific Ability (inferiority, apparently inborn, of particular mental functions: "memory," "attention," "observation," "judgment," "reasoning," "motor co-ordination," hitherto observed only in conjunction with other factors (A, 4; B 1, 3–7) acting either as cause or effect)... [22 per cent.]

3. Weak General Educational Ability (*i.e.*, inferiority, apparently inborn, affecting efficiency in several school subjects, often hereditary, but unassociated with marked weakness of general intelligence, and often compensated by non-scholastic ability and interests) ... ... 15 per cent.

4. Specific Educational Defect (*i.e.*, inferiority apparently inborn, affecting one group of allied subjects only, often compensated by interest or aptitude in other special directions): (*a*) chiefly affecting power to manipulate verbal symbols (reading, spelling or dictation) ... ... 8 per cent.

5. Specific Educational Defect: (*b*) chiefly affecting power to manipulate abstract numerical symbols (number, arithmetic ... ... 9 per cent.

6. Defect of Character: due chiefly to (*b*) inborn emotional or moral instability, often hereditary ... 11 per cent.

7. Intrinsic Irregularity of Mental Growth: (retarded development, likely to be compensated later on, often associated also with slow physical development, but not clearly assignable to any extrinsic cause) ... ... 7 per cent.

Of the backwardness that is secondary or acquired, most should be preventable or remediable. Of the backwardness that is apparently primary or inborn, some may be traceable with prolonged observation and analysis to extraneous causes, and therefore be relegated to the first group. The remainder, though hardly preventable without the indirect application of eugenic principles, may still prove remediable to a very large extent. The remedies must be partly social, partly medical, and partly educational. With the last alone are we here directly concerned.

Methods of dealing with Backwardness (Tentative Suggestions only).

The common characteristic of backward children is that their rate of educational progress is much slower than that of the mass of the children in ordinary schools,—about three-quarters of the normal rate. On an average a year behind at five, two years behind at ten, nearly three years behind at fourteen, they pass through only seven grades and standards while the ordinary child passes through ten. The ideal arrangement, therefore, would be a series of classes parallel to the customary series, where promotion was slower, or the increase of difficulty less. Since backwardness affects scholastic and abstract work more than practical or concrete, the curriculum should include a large proportion of concrete and manual work; and the teaching methods should be similarly adapted. Every appeal should be made to the nobler emotional susceptibilities—self-respect, musical and artistic taste, craftsmanship, etc. Additional fresh air and rest will be needed for classes in poor neighbourhoods: and many cases will need stricter following-up into the homes to see that proper medical

treatment is obtained, and neglect and evil influences as far as possible removed. The classes should be small in number, not only because these children need more individual attention in their work, but also because each class needs close observation and enquiry. Conditions should be systematically analysed; progress systematically tested; and accurate records kept of both in terms of objective facts rather than personal impressions. Above all, teachers should learn more of the methods of discovering, analysing and treating backward cases; and should be encouraged to make and disseminate contributions themselves. Too often when discovered the backward child is merely ignored, or else passed on to another school or class where he is accepted, and his condition has once more to be slowly rediscovered. The feeling that he is not wanted, not understood, not like other children, in short, subnormal and a nuisance, damages the child far more than the subnormality itself.

In certain districts backwardness is unusually prevalent, They are usually overcrowded areas with many schools near together. Here, provision could best be made by collecting cases from several schools, and converting either an empty special school, or one of the ordinary schools, into an intermediate school recognised as provided for children of a lower grade.

In most cases, a parallel series of classes will be impracticable. Here a single special class may be formed, recruited either from several neighbouring schools, or from the department in which it is located. Such provision is needed most urgently for older children; and in such cases it will be unwise to mix the sexes. With younger children, backward cases may be more profitably collected from all three departments, infants', boys', and girls'.

Such a school or class should not be advertised to its members as a school or class for backward children. For example, when level with standards III. or IV. many teachers rightly prefer to designate it standard VIII. Both teacher and children should feel it is a privilege to work in such a school or class.

In its various forms, the latter method, the organisation of a backward class, has been successfully adopted by head teachers, either spontaneously or in response to recommendation, in several schools of the borough here reviewed. On being traced, a large proportion of the children in the -2 S.D. section prove already to have been accommodated in such special classes. When concluded, the study of the individual cases will probably yield evidence for accommodating much of the remainder of this group, and possibly much of the -3 S.D. group, in a similar way. Revised suggestions will be available as to curriculum and methods.

Much, however, can be done without the institution of a special school or class. Teachers may readily be brought to realise that the backward individual in their care is not an anomaly,—likely if discovered, to bring discredit on the management of school or class; but part of a recognised educational problem, for which a definite treatment is already being devised. The classification of children might be improved in many schools; and sub-classification introduced in many classes. Apart from other considerations, a class will always be more efficiently taught if it is fairly homogeneous. Where a large mixed group has unavoidably to be dealt with, the probable form in which ability is distributed might well be observed. Teachers have scarcely realised that average children resemble each other fairly closely in their abilities, and form the largest proportion of a random group. It is towards the upper and lower extremities of the group that individual differences are greatest, but here the numbers are

few.[1] In a class of sixty children, forty will probably work at approximately the same pace. About ten will be able to work appreciably faster, but at very different paces among themselves, and may well be left to do so. Ten or a dozen will work more slowly and again at very different paces among themselves. It is upon these that personal attention should be concentrated. Individual teaching need not be dissipated indiscriminately over the whole of a large class, but should be reserved for those who need it most.

Often cross-classification can be adopted. A child who is backward in arithmetic need not necessarily be relegated to a lower class for every other subject as well.[2] Older children, too, who are backward in all educational subjects are often normal in practical good sense. If placed among younger children, and still perhaps the dullards of their class, they may yet make efficient prefects. A position of responsibility will often stimulate their self-confidence and keep alive their self-respect; and perhaps thus give impetus to their educational work.

With backward children a particularly high return will accrue from any additional expenditure incurred. The efficiency of both ordinary and special schools will in many ways be increased: and, indeed, a saving may actually be effected in the latter.

Special provision for backward and borderline children is thus recommended as an urgent educational reform. It is further needed in the interests of the community as a whole. From the ranks of backward children are recruited the majority of the most undesirable members of society. "Mental defect," it has been said, "forms the largest single cause of delinquency." The statement is based upon a recent psychological study of a thousand juvenile criminals in America; and has often been echoed in this country. But it is probable that, among the majority of delinquents, the mental inadequacy is neither of the kind nor of the degree that in this country has been technically termed "deficiency." They fall rather into the borderline group of cases. In early years they come under special notice primarily because they are educationally backward. In addition, they may show troublesome moral, emotional or physical peculiarities. These are probably the cause of their backwardness at school, and will probably prove the cause of delinquency in later years. For the rest, out of school they are fairly intelligent, often cunning in action and plausible in speech. It is plainly undesirable to recommend them, as is now often done, for admission to a school for mental defectives, on the ground that their "defect" is, in popular if not legal language, a "mental" one. Both in school and out of school they will be far in advance of the rest of the children in a special (M.D.) school. Upon these they will impose their will and their ideas. From these they will learn nothing but the half-unconscious simulation of a feebleness of mind to cover their own misdeeds. Nothing but ill can accrue to either party from such an association. *Eventually, it will probably be necessary to recognise a further group of children, the "unstable,"—children whose mental insufficiency primarily affects not their intelligence or scholastic ability, but rather their impulses, instincts, emotions, moods, and moral self-control, in a word, their temperament or character.* Since they usually become backward in class-work as well, they can provisionally be dealt with under the category of "backwardness."

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(1) For the most probable distribution of ability within a class or age-group, see Table XVII., p. 49, and Table XXXII., pp. 90-1. In the following statement, I use the limits of + and − 1 S.D. from the average, within which fall 68·3 per cent. of the individuals of a normally distributed group. On studying the form of the normal curve of frequency (*e.g.*, in Figure 7), the reader will observe that the rate of decline changes at + and − 1 S.D. The curve is convex down to this point, and then becomes concave. At these points, then, the outer limits of 'dense medium' may be arbitrarily fixed.

(2) For further suggestions upon this point, see *Memorandum* III., pp. 73-74.

CALCULATIONS FOR LONDON.

Method of Sampling.

It is possible from a fair, unbiassed sample to estimate the characteristics of a more comprehensive whole; and even to calculate the margin for error that must be allowed. Accordingly, the figures obtained in the present survey may be made the basis of a calculation of the distribution of educational ability within the whole county of London. Were the sample examined chosen absolutely at random, had every twentieth child, for example, been selected by lot or alphabetically from the roll of every school, then the probable error made in calculating the relative frequencies from the figures for the several classes would range, from a very small fraction up to 0·7 per cent. for normals and to 1·5 per cent. for defectives.

The children investigated, however, do not constitute an entirely random sample. They are chosen all from one borough. Nevertheless, there is reason to believe that in most essentials the borough is a representative one. The accommodation for defectives is as we have seen unusually high. But the ordinary elementary school population is probably but little below the average level of intelligence that would be found in London schools as a whole. For rough purposes, therefore, the above estimate of the margin of error may be accepted. Could a complete census of educational ability be taken for the whole of London, could an examination upon a uniform basis be organised throughout the county, the figures might appreciably be modified. The general range, the general variability, the proportion of moderate backwardness and of moderate advancement, the overlapping with defectives—these would doubtless be appreciably increased. But the chief result would be an estimate of the special needs of special districts. The general characters of the distribution as a whole would probably remain but little affected.

The figures, however, which I give are intended rather to illustrate the possibility of basing estimates upon a method of sampling. I do not claim that they are themselves any more than a first and probably very inaccurate approximation to the true numbers.

Calculated Distribution of Educational Ability for the Whole County (Illustrative Estimates Only).

The figures for the rolls of all London schools, ordinary and special, are not yet available for the current year. For provisional calculations, therefore, I base my estimate upon reports for preceding years. Assuming the same rate of increase as those exhibited in previous returns, I estimate that at the time of my survey the number of children, over eight and under fourteen, upon the roll of all Ordinary Elementary Schools in London was 441,289; upon the roll of all special (M.D.) schools, and between the same age-limits, 6,504. The combined group, therefore, numbers 447,793. Of these, about 1·45 per cent. are certified to be "defective" and are actually accommodated in special (M.D.) schools. Of the remainder, 7·3 per cent. upon the very lowest estimate, nearly 35,000 individuals in all, are "backward" in the sense already defined. It will be remembered that this is a conservative estimate. It makes no special allowance for higher proportions in the poorest localities; it makes but little allowance for the numerous cases of backwardness unrecognised by teachers; it permits older children to fall far behind

their age before considering them as definitely "backward"; and, finally, it refers only to certain age-limits. With further allowances for these considerations, the total number of backward may well rise to forty or fifty thousand children.

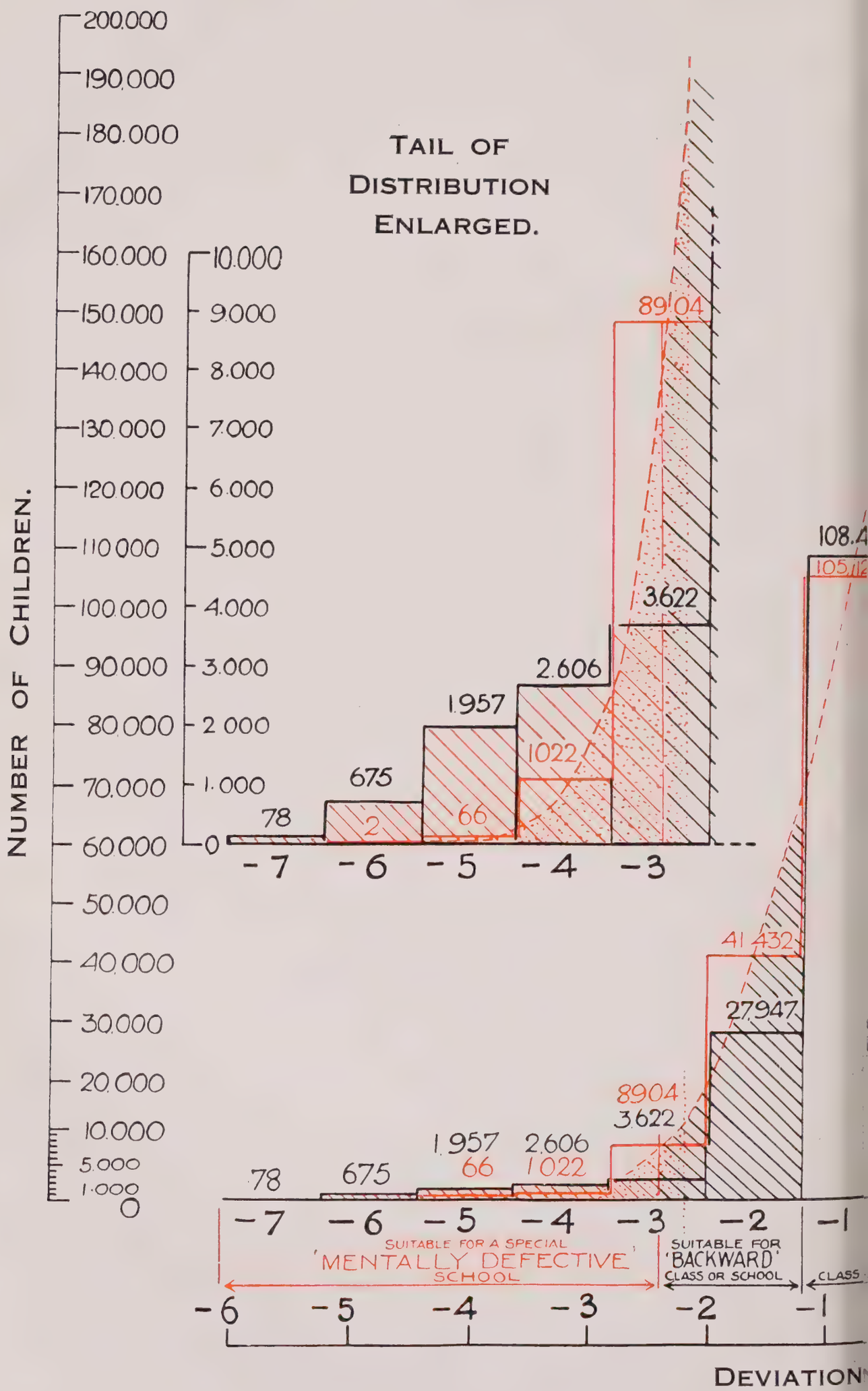
To estimate the frequency of the various degrees of backwardness, the number of defectives of each degree (−1 S.D., −2 S.D., etc.) must be raised in the proper proportion, and added to the estimated number of ordinary school children backward in a corresponding degree. Left with the addition only of defectives to its lower tail, the distribution would become once more distinctly skew. The true distribution is, I suspect, a little skewed in this direction. But we do not know the degree of skewness. Hence, symmetry is at once a safer and simpler assumption. We may retain it by including a rough estimate for the older brighter children who escaped the original survey, for example, junior county scholars. To compensate, we may assume that their numbers and distribution correspond with those of the defectives; and add appropriate frequencies to the upper sections of the distribution. This makes the distribution approximately symmetrical, and yields a total of 454,297 as a very rough working estimate of the entire school population for the County of London within the limits observed. To make the distribution perfectly symmetrical, analogous frequencies on either side of the middle line have been averaged. The standard deviation of the combined distribution becomes 1·24, the unit throughout being the original standard deviations of the component age-groups. The distribution thus obtained is shown in Figure 7.

Although symmetrical, the new distribution is no longer normal. It has again become peaked. But for working purposes, it is often advantageous to assume that the distribution is not only symmetrical but normal as well; by the use of tables of values for the normal probability integral we can then at once estimate the number of cases that will be cut off at any given point upon the scale, and the point upon the scale, which must be chosen to cut off a given number of cases. The "normal" frequencies for a group of the same size and variability have been roughly calculated; and the "normal" curve and column-graphs are shown in Figure 7 in red. On contrasting the theoretical distribution with the observed, it will be seen that in the latter too many are bunched into the central section (0 S.D.) and thrust out into the extremes (2 to 6 S.D.); while the sections between the centre and the tails are shrunken. Once more, it may be suggested that exacter estimates would fill out these hollows by transferring thither the slighter cases of backwardness and advancement that now seem too closely clustered about the centre of the group. There is, however, a valid reason for expecting that even then the combined distribution would differ somewhat from the normal curve. Within the "defective" tail are now included a small but appreciable number of pathological cases, that could not be obtained from a group of "normals" normally distributed, however large. Accordingly, in the absence of more accurate information, it may be well to consider the two different estimates that will ensue from the two different assumptions as to the character of the curve of distribution.

Highest Line of Demarcation between Ordinary Elementary and Special (M.D.) School Children.

The average ability of special school children, and the average line of demarcation actually found between them and the children in ordinary schools have already been stated.[1] Owing to the variety of the qualifications that have to be considered, the upper limit must fluctuate from case to case

(1) *Memorandum* I., p. 10; and *Memorandum* II., p. 35.



(Between pp. 42 and 43.)

Figure 7.

CALCULATED DISTRIBUTION OF EDUCATIONAL ABILITY AMONG THE CHILD POPULATION OF LONDON

ELEMENTARY SCHOOLS
(ORDINARY AND SPECIAL M.D.)

AGES 8- TO 13-

NUMBER OF CHILDREN, **454,297**

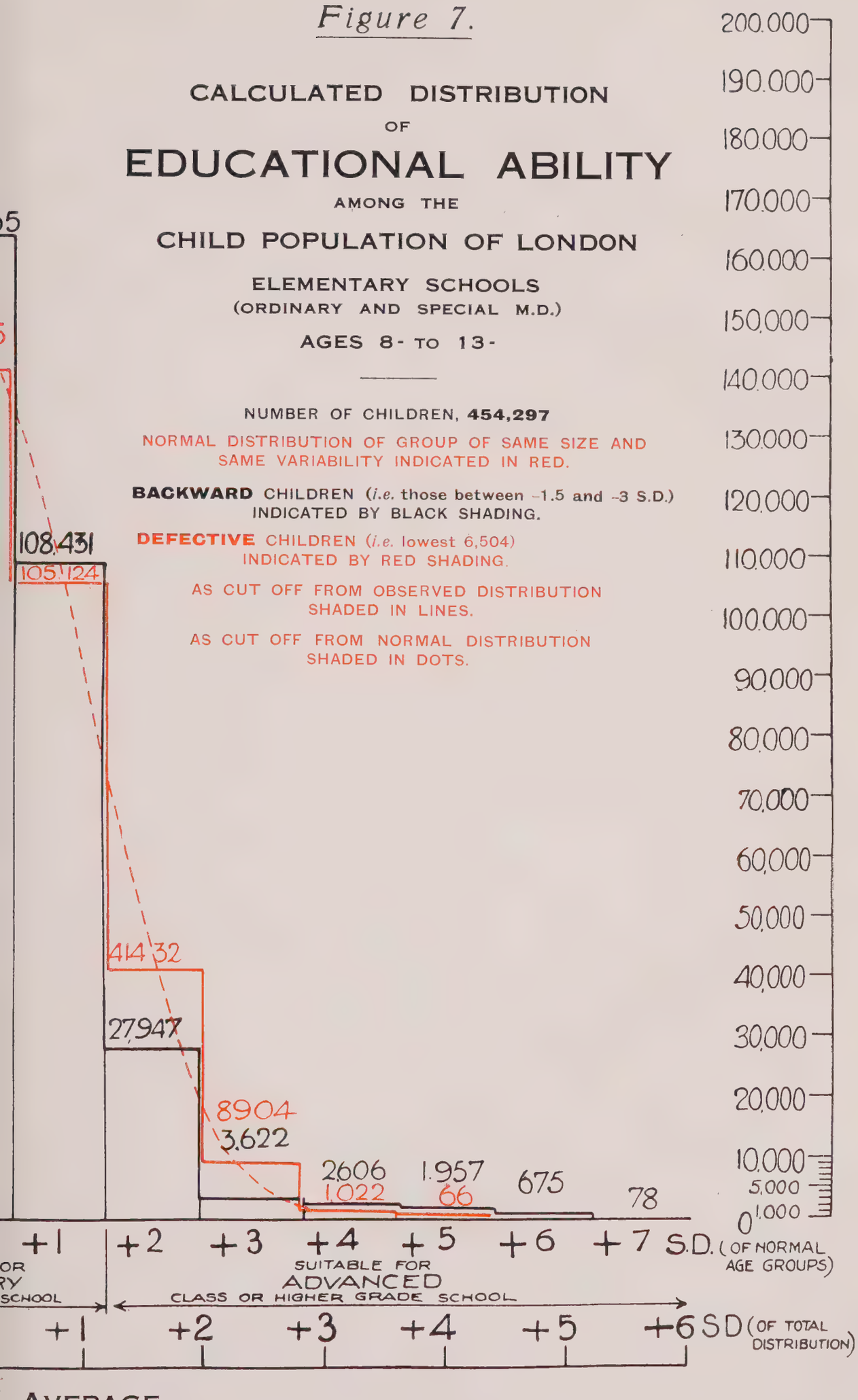
NORMAL DISTRIBUTION OF GROUP OF SAME SIZE AND SAME VARIABILITY INDICATED IN RED.

BACKWARD CHILDREN (*i.e.* those between -1.5 and -3 S.D.) INDICATED BY BLACK SHADING.

DEFECTIVE CHILDREN (*i.e.* lowest 6,504) INDICATED BY RED SHADING.

AS CUT OFF FROM OBSERVED DISTRIBUTION SHADED IN LINES.

AS CUT OFF FROM NORMAL DISTRIBUTION SHADED IN DOTS.



It is, therefore, important to decide also what is the highest level it may legitimately reach,—what is the mildest grade of backwardness that may reasonably be admitted.

It is educational disability that separates special school children most widely from the normal. This, therefore, may be used as criterion for our problem. For the purpose of calculation two fictitious assumptions may be made: first, that the children are to be selected solely upon the ground of educational deficiency; secondly, that the accommodation is to be completely filled with the educational defectives thus selected. At what point upon the educational scale is the line between "normals" and "defectives" to be drawn, so that both these conditions may be satisfied, and the two groups not overlap?

The total accommodation of all the special (M.D.) schools (1915–16) is 7,975. Of this, I estimate 86·07 per cent. is available for children between eight and fourteen. We have, therefore, to find defectives for some 6,864 places.

To obtain the 6,864 most backward cases from a normally distributed group numbering 454,297, we must cut off the bottom 1·51 per cent. This will be done by a line drawn at −2·17 times the standard deviation of the composite group. This new standard deviation is 1·24 times the original standard deviations of the several ages. And these in turn are approximately tenths of the age. *The minimum retardation, therefore, likely upon our hypothesis to qualify a child for admission to an (M.D.) school is* 26·9 *per cent., or rather more than one-quarter, of his age.*

If instead of the "normal" distribution, we take that actually observed, then the line will be drawn at about −2·5 times the standard deviation of the composite group. This is equivalent to requiring a retardation of about 31 per cent. of the age.

These limits correspond to an "educational ratio" of 69 to 73 per cent. Apart, therefore, from non-educational considerations of a most exceptional kind, no child who has three-quarters or more of the educational attainments proper to his age should be even considered as a potential candidate for admission to an (M.D.) school. In the case of candidates who are retarded by less than 31 per cent. of their age, and, therefore, have over two-thirds of the normal attainments, evidence of deficiency in general intelligence or in emotional stability should also be required. Even for all who have more than half the normal attainments it is desirable. Often such evidence will be obtained only after prolonged observation in a sorting-class or clearing-school.

It may be convenient to translate these requirements into concrete terms. The following table is, therefore, appended. It indicates for every age the highest possible educational limit that can be recommended in nominating candidates for the statutory examination with a view to admission to a special (M.D.) school. The level specified is that *below* which a child must fall before he can be deemed a suitable case to present. Except in cases of non-educational deficiency, admission would hardly seem justified unless the child fell below these levels by a further amount, varying according to age, from a third to half a year. Thus, for nomination, a child of eight must fall below grade 3·0, *i.e.*, below the dividing-line between grades ii. and iii.: a child of nine must fall below the upper third of grade iii. For admission they will usually fall below the upper half of grade ii. (Gr. 2·8) and the middle of grade iii. (Gr. 3·4) respectively. Children corresponding to grade iii. at eight, to standard I. at nine, to standard I. or a poor standard II. at ten, to standard II. or a poor standard III. at eleven, and so on, may be recommended rather for a backward class.

TABLE XVI.—UPPER LIMITS FOR CANDIDATES NOMINATED FOR THE STATUTORY EXAMINATION FOR ADMISSION TO A SPECIAL (M.D.) SCHOOL.

('Requisite retardation' is taken as 2/9 times age. 'Upper limit' is obtained by subtracting retardation from class, as given in Table X., column 3.)

Age.	Requisite retardation.	Upper limit in grades and standards.
6 — years ...	1·7 years	Gr. 1·7. Grade i., upper third.
7 — years ...	2·0 years	Gr. 2·3. Grade ii., middle third.
8 — years ...	2·3 years	Gr. 3·0. Grade iii., bottom.
9 — years ...	2·6 years	Gr. 3·7. Grade iii., upper third.
10 — years ...	2·9 years	St. 1·3. Standard I., middle third.
11 — years ...	3·1 years	St. 2·0. Standard II.
12 — years ...	3·4 years	St. 2·7. Standard II., upper third.
13 — years ...	3·7 years	St. 3·1. Standard III., middle third.

The Supernormal and the Advanced.

It is among subnormals that my work has chiefly lain. Hence, it is primarily with problems of educational backwardness and deficiency that the foregoing pages are concerned. Analogous methods, however, could be applied to determine the limits of supernormality, and to discover the numbers of the supernormal and the advanced. Thus, in the year preceding my enquiry 2·3 per cent. of the children aged $10\frac{1}{2}$ years gained Junior County Scolarships, and the next 7·8 per cent. apparently were transferred to Central Schools. This top 10·1 per cent. might be denominated technically "advanced," much as the bottom 10 per cent. has been designated "backward." Such a designation might be extended to cover all age-groups. These proportions are cut off by lines +2·01 and +1·28 S.D. above the average in a normally distributed group: or, reducing the figures from terms of the total distribution to that of the ordinary age-groups, at about $+2\frac{1}{2}$ and $+1\frac{1}{2}$ times the original standard deviations. Thus, potential candidates for central schools are advanced by about 15 per cent. of their age, and potential scholarship children by about 25 per cent.

In the case of the "advanced" similar questions call for investigation. What causes promote or hinder educational advancement? What tests are most efficient in selecting those who are superior in general educational ability? What further tests are needed to select those who are gifted in some special way—for example, in technical, manual, or in specifically academic ability? How far is educational precocity or scholarship ability a reliable indication of adult superiority in general intelligence? And, finally, what further provision is needed for those who by reason of age or home circumstances are unable to enter central or secondary schools—for example, special classes or special schools for the supernormal, or special modes of promotion for the advanced?

These questions, and others similar to those discussed in the case of the backward, can best be anwered by means of specific investigation. If the child population and the community at large have profited by the establishment of special schools and classes for the educationally incompetent, much more would they profit by refining the procedures for discovering and training those who are the most efficient of their age. Here, therefore, lies a valuable field for future surveys and for future research.

MEMORANDUM III.

ON THE RELATIONS BETWEEN ABILITY IN DIFFERENT SUBJECTS OF THE SCHOOL CURRICULUM.

Effects of Teaching.

In the foregoing reports I have assumed that educational ability may be treated as a single quality. I have not distinguished between inherent capacity and acquired knowledge, nor yet between general ability and special aptitude.

Inherent capacity is largely the result of inheritance; acquired knowledge, of teaching. If inherited capacity could be assessed quite independently of the results of instruction, the foregoing estimates might (it may be imagined) need considerable correction. It may seem possible that, in certain schools, and still more in certain classes, the apparent backwardness of the children is due merely to ineffective teaching. Such cases should readily be discoverable by an extension of methods here used. But, from the characteristics of the observed distributions, it seems clear that such cases are not numerous. Again, in other schools and classes, it may seem possible that the particular excellence of the teaching may cause the children to appear unusually advanced. But, in reviewing a large area, the results of exceptional efficiency or inefficiency in teaching will be comparatively small, and probably to a great extent be neutralised by each other in the general averages. The main effect of teaching upon educational ability is, as a rule, to increase the individual differences already present from birth. Children who are naturally bright learn rapidly, and are promoted rapidly to higher classes. Children who are naturally dull learn comparatively little; they tend to remain at the same absolute level so long that their relative backwardness increases year by year. Hence it is, in part, that the "standard deviation"—the measure of the degree to which individuals of a given age-group differ from one another—increases from about half a year at the age of five to a year and a quarter at the age of thirteen (see Memorandum II., Figure 5). Occasionally, towards the end of his career, a bright boy may be allowed to mark time in an upper standard while others catch up to him. Occasionally, by special coaching, a backward child may be brought up more nearly to the normal level. But, in the main, it is comparatively rare to find original differences lessened in this way by the efforts of teaching, and rarer still to find them reversed. The main effect of teaching, therefore, so far as it affects the validity of our estimates, is to allow the original differences of ability to develop, to increase, and to become more distinct. Nevertheless, as will appear from what follows, superior and special abilities are by no means as yet elicited and developed to their utmost.

Effects of Special Aptitude.

A more hazardous assumption is involved in treating each child as of equal ability in all subjects.

A child who is of the level of, let us say, standard IV. in one subject—for example in Arithmetic—has been regarded as of the same level for all other subjects—Reading, Dictation, Composition, and so forth. If he is backward at all, he has been treated as backward for every subject, and backward by the same amount for each. In practice, most elementary schools are organised upon this basis. A child is allotted to the same class for every

subject of the curriculum. It is, therefore, of importance, both theoretically and practically, to enquire how far this assumption is justified.

Is there such a thing as General Educational Ability? Is there a single common factor determining in varying degrees attainments in each and every subject? Or are the various school activities quite unrelated, so that a separate survey should in strictness be carried out for each?

To these questions I have already attempted a provisional answer in previous publications. The conclusions there reached have to a large extent been since confirmed by independent investigators. Accordingly, a fuller account of both methods and results seems now justifiable. Owing to the extraordinary complexity of the subject, the results must still be regarded as no more than tentative. The methods, however,—particularly the graphic methods of analysing the level of attainments in different subjects for different schools, classes, ages, and individuals—will be found helpful, it is believed, to head teachers and to others whose duty it is to survey the work of entire schools. These, therefore, are given in some detail.

Scientific Inadequacy of School Marks.

A study of school marks should throw light on this subject. But school marks are generally allotted for other purposes than the mere scientific measurement of capacity or attainment. They are often bestowed for encouragement or reward, and lost through absence or misconduct. Marks, too, normally awarded for ability in one subject—for instance, Composition—often already include marks for other abilities—such as Writing or Spelling. Spurious correlations are thus introduced. Further, it is seldom that the examinations are carried out twice upon precisely comparable lines. And from but a single examination it is difficult to estimate exactly a child's capacity and impossible to measure the reliability of that estimate. In certain subjects—*e.g.*, manual subjects, and special subjects like history and geography—the examination results are often very unreliable; and to obtain reliable estimates at all probably needs at least two or three distinct examinations. Hence, except for purposes of corroboration, the results of the ordinary school examinations have been discarded. A special set of tests and a special system of marking have been employed instead.

Selection of Children.

The same child may appear behind the rest of his class, not because his General Educational Ability is weak, but because the rest are older than he or have been longer in the same class. Accordingly, in investigating the existence of general ability, it is essential that the group tested should be very carefully chosen. As far as possible, the members should be upon the same level in all respects except ability. The main groups eventually selected for the present experiment consisted of three classes from different schools. In educational level they corresponded to standard V.; and comprised 120 children of the same sex, differing but little in age, zeal, attendance and social status, taught by the same teacher for all subjects and for about the same period of time. Groups of younger and older children of both sexes were also tested. But the differences due to age and sex will be but briefly mentioned in the present report. For simplicity, the results obtained with the main groups will alone be described in detail.

Selection of Tests.

Special tests were drawn up for the following subjects: Composition, History, Geography, Science (Nature Study), Mechanical Arithmetic (Rules),

Arithmetical Problems, Reading (Fluency and Comprehension), Writing (Speed and Quality), Dictation, Drawing, and Handwork. All the children were tested at least twice in each subject upon different days. The tests were applied personally,[1] and the papers marked (with one or two small exceptions) by the same individual throughout.

Scheme of Marking.

Most of the subjects possess an obvious unit of measurement. Ability in Dictation can obviously be measured by the number of words correctly spelt; ability in Mechanical Arithmetic by the number of figures correctly given in the answer. Other subjects, such as Drawing and Handwork, possess no such obvious unit. The work, however, can readily be arranged in rough order of merit, or marked upon the basis of general impression. Ordinarily the description of such impressions varies greatly from teacher to teacher. Work marked "average" by one teacher would be marked "good" by another, and "poor" by a third. If expressed in numbers, "full marks" may range anywhere from 5 to 100; and the average may lie now near the top of the scale, now near the bottom. A standard scheme of marking, therefore, is urgently needed.

Numerous practical purposes would be served by such a scheme. In reporting upon special individuals,—*e.g.*, borderline cases submitted for possible admission to a special (M.D.) school, candidates for promotion, scholarship, or transfer,—teachers often assess abilities in different subjects in terms of marks. Such a statement, however, as "Arithmetic = 0" is, with the present system of marking, highly ambiguous. The following interpretations have, at different times, been given: "no sums right out of 4"; "no sums right out of 10"; "no marks in a percentage scale with 100 full"; "one of several who obtained no marks"; "the worst—in his class," "—of his age," "—in his school," "—in my experience as a teacher"; "specially deficient in arithmetic"; "mentally defective and incapable of learning arithmetic at all." These represent very wide differences in arithmetical disability—differences larger than those commonly obtaining among the rest of the class. Yet all are awarded the same mark, namely, zero. Similar differences also obtain in the case of extremely high ability. We need in particular, therefore, a scale of marking which shall provide free scope for differentiating rare, but differently graded degrees of merit and demerit. *These requirements can readily be fulfilled by defining marks in terms of frequency,*—"as bad" (or "as good") "as one in a random sample of 50," "as bad as one in 100," "—in a 1,000," or "—in 10,000."

Again, teachers' reports upon children leaving school and seeking employment have commonly to state the child's intelligence and character. Yet they seldom convey any definite meaning except to those already familiar with the particular teachers' standard. Too often the apparent estimates of capacity prove to be but vague testimonials. Such reports often envisage moral qualities, which at first sight seem to lend themselves to no scientific method of measurement. Here again the best method of defining the grades to be recognised is in terms of their relative frequency. In more than one school a system of card-indexing the children's qualities has been worked out, together with a uniform scale of marking for all subjects and classes. None of the scales, however, to my knowledge, are based on the recognised statistical principles which should govern such measurements.

The formulation of a simple standard scheme for the distribution of marks is made possible by the conclusion for which the foregoing memoranda

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(1) I am especially indebted to the courtesy of the head masters and head mistresses in affording me every facility for carrying out these tests.

have argued, namely, that mental abilities are distributed very nearly in accordance with "the normal curve of error." This conclusion suggests that a definite scale of frequencies obtains approximately for different degrees of ability. The following recommendations, therefore, may be drawn up as embodying the general principles to which a standard scheme of marking should conform:—

(1) Within a single class, and with a single qualitative test, it is seldom possible to distinguish with certainty more than 10 or 20 degrees of merit. Except with a large and heterogeneous group, a scale with 100 degrees implies a minute discrimination of quality which seldom can truly be attained.

(2) On the other hand, a scale with fewer than 10 degrees provides a classification so coarse that correlations and calculations based upon it would hardly be statistically sound.

(3) No mark should be repeatedly awarded simply because it is a round number.

(4) No mark should be repeatedly awarded simply because it is arbitrarily chosen as a "pass-mark," *i.e.*, as representing the minimum degree of attainment required in a particular class.

(5) Abilities near the average are more frequent than extremely high or extremely low degrees. This excludes the repeated award of marks near the maximum or near zero. Only once in many hundred occasions will work of such superlative merit or demerit appear. And then it is important to have a mark available for it upon the ordinary scale. Further, these extreme cases may differ considerably among themselves. Plenty of scope, therefore, should be provided for accurately grading such rare but important cases.

(6) The average mark of the whole class should usually fall in about the same place, near the middle of the scale. The group should never be divided into two nearly equal halves (*e.g.*, "Good" and "Bad," "Above Average" and "Below Average"), even though the divisions are still further sub-divided; nor should it be divided at the centre of the scale, since ties are here most frequent.

(7) The degree to which individuals are scattered above and below the average should, apart from special reasons for the contrary, be about the same in different subjects. According to the usual methods of marking, the "standard deviation" found in subjects like Arithmetic appears higher, as a rule, than that found in subjects like Composition. For some candidates may work all the sums correctly and some may work none correctly; but no compositions are deemed perfect, and none, perhaps, of no merit at all. Hence, extreme marks—"full" and "zero"—are obtained comparatively often in Arithmetic but never in Composition. Yet there is no reason to suppose that literary ability is less varied than arithmetical. Hence, for purposes of strict comparison, the original marks in each subject should first be reduced to terms of their average or "standard" variation. A special problem arises on comparing General Educational Ability and a specific educational capacity. The former is often, and the latter may be, expressed in terms of backwardness. But it is clear that children who are backward by a year in all subjects will be much rarer than children who are backward by a year in but one subject. Here, therefore, there seems to be a limit to the usefulness of a uniform scale based upon the standard deviation.

(8) In technical language, then, the marks should conform approximately, but not be forced to conform exactly, with a "normal" distribution, whose unit of scale, expressed in terms of the "standard deviation" from the average, is the same for all subjects and for all teachers. "Arithmetic $= -2\frac{1}{2}$ S.D. (age)" is a precise and definite statement. It would mean "the child's ability in arithmetic deviates below the average of his own age-group by two and a-half times the standard deviation of that age-group." A case as bad as this would occur, with random sampling of a normal group, only about 6 times in 1,000. The individual would probably be an unusually bad case for his class, very likely the worst in his age-group, but perhaps not the worst case in an ordinary department of three or four hundred children.

(9) In actual work, however, fractions and algebraic signs readily lead to serious clerical errors. A minus sign may easily be omitted, or typed in error for a plus. Zero, too, conveys to most teachers not an average degree of merit, but the lowest degree of merit. A practical scale, therefore, should more nearly resemble the systems of marking already in common use. At the same time, the central or "average" mark should be some simple round number, so that the degree of deviation needs no elaborate subtraction, and the unit should be some simple multiple of the standard deviation.

The following scale conforms to these principles; and was found of much service in the present investigation. It is here suggested tentatively as a first step towards a uniform scheme of marking. It would plainly save much trouble, ignorance, and misunderstanding, if assessments could be made in terms of a Standard Scale. "Arithmetic, 6 (S.S.)" would then provide a very simple, intelligible, and unambiguous formula. It is not, of course, for a moment intended that such a scale should be everywhere and at all times used, but merely that it might be adopted where marks are intended to convey comparable quantitative estimates to teachers and officials.

TABLE XVII.—STANDARD SCALE OF MARKING.

Degree of ability.			Number of children probably exhibiting each degree of ability.			
Mark.	Deviation from average in terms of standard deviation.	Suggested designation.	Theoretical percentage.	Suggested number in a group of about 100.	Suggested number in a group of about 60.	Suggested number in a group of about 40.
0 to 4	-3 or more	(Special cases)	0·30	}		}
5	$-2\frac{1}{2}$	Extremely bad	0·92	1	1	}
6	-2	Very bad ...	2·78	3	2	1
7	$-1\frac{1}{2}$	Bad	6·56	6	4	3
8	-1	Very poor ...	12·10	12	7	5
9	$-\frac{1}{2}$	Poor	17·47	18	10	7
10	0	Medium ...	19·74	20	12	8
11	$+\frac{1}{2}$	Fair	17·47	18	10	7
12	$+1$	Very fair ...	12·10	12	7	5
13	$+1\frac{1}{2}$	Good	6·56	6	4	3
14	$+2$	Very good ...	2·78	3	2	1
15	$+2\frac{1}{2}$	Excellent ...	0·92	1	1	}
16 to 20	$+3$ or more	(Special cases)	0·30	}		}

It will be seen that the average mark is 10; the "standard" or root-mean-square deviation, 2. Marks below 5 and above 15 are reserved for cases which are not only unique in the group actually examined, but also unique or nearly unique in the teacher's experience; theoretically, the marks 4 (and 16), 3 (and 17), 2 (and 18), 1 (and 19), 0 (and 20) should occur approximately 24 and 4·9 times in 10,000, 7·8 times and once in 100,000 and once in 1,000,000, respectively, in a normal distribution. But they will be required chiefly in abnormal cases, such as those of pathological defect; and will best be defined in terms of averages of age-groups above or below the age-group determining the average of the scale.

Vague terms, such as "good," "bad," etc., if used at all, should be given a definite meaning as above. Thus, "Good" is here taken as meaning a degree of ability reached (or surpassed) by only one child in 10: "Fair," a degree reached (or surpassed) by 4 children in 10, or 2 out of 5: "Medium," the degree characterising the middle fifth of the group. "Bad" is used as the common opposite to "Good"; but it would perhaps be preferable to substitute a term implying less culpability; for instance, "Weak." Even the moral implication of "Good," "Fair," "Excellent" is perhaps objectionable. "High," "Low," "Above Medium," "Below Medium" might be suggested; but they do not lend themselves so readily to abbreviation by familiar initials.

It should be specified whether the distribution contemplated is that of an ordinary age-group, a fair sample whose average ability is neither above nor below the usual, or a selected group, such as a given school class or standard, or an age-group in a particularly advanced or backward school. For single capacities the foregoing scheme will probably be available both for age-groups (Table XVII., last column but one), and for school-classes (Table XVII., last column), except where the capacity is itself the chief basis upon which the class has been selected. It is further available for designating moral and emotional qualities: for here also degrees can best be defined in terms of frequency.[1]

This, then, was the scale used in the present investigation to mark abilities at tasks such as Composition, Drawing, Handwork, Handwriting (Quality), in which the task itself furnished no obvious scale of marks. In the other tests—Arithmetic, Dictation, History, Geography, Science, Reading (Comprehension), Speed of Writing and of Reading—the nature of the mark to be used is obvious: the number of figures correctly worked, the number of words correctly read or spelt, the number of questions correctly answered, the number of words or letters read or written in a given time.

(1) Many teachers profess themselves unable to distinguish more than five or six grades of excellence, especially in moral qualities, and in those for which no special examination is held. Perhaps, for such purposes as the school-leaving form this may be all that is possible or requisite. In such cases, I would suggest a code of letters, corresponding to entire standard deviations, as follows:—

Symbol	A.	B.	C.	D.	E.
Significance	Much above average	Above average	About average	Below average	Much below average
Frequency	Top 7 %	Next 24 %	Middle 38 %	Next 24 %	Bottom 7 %
Corresponding Deviation..	+ 2 S.D.	+ 1 S.D.	0 S.D.	− 1 S.D.	− 2 S.D.
Corresponding Description in Table XVII	Very good	Very fair	Medium	Very poor	Very bad

Exacter percentages are given in Table XIV. (last line). It will be remembered that, in educational ability, at the age of 10, −1 S.D. signifies a retardation of about one year.

Correlation.

If attainments in two or more different subjects, such as Arithmetic and Reading, are partly determined by a single common factor, such as general educational ability, then the marks obtained by a given child for one subject, *e.g.*, Reading, should resemble those obtained by the same child for the other subject, namely, Arithmetic; if for Reading they are well above the average, then they should also be well above the average for Arithmetic. The enquiry, however, turns not merely on the existence of such resemblance, but on its amount. We shall see that, in the long run, the marks of a given child tend to show resemblance for all subjects to a greater or less degree; but that the degree of that resemblance varies considerably in different cases.

The degree of resemblance can be readily measured by the statistical figure known as a "coefficient of correlation." Roughly speaking, it may be said that a coefficient of correlation measures the most probable deviation in one subject accompanying a unit amount of deviation in another. If the relationship between the two measurements is complete (as, for instance, between two perfect measurements of the same capacity), then the coefficient is unity. If, therefore, the correlation between Reading and Arithmetic was 1·00, the top boy for Reading would be top also for Arithmetic, the boy most backward in Arithmetic would also be most backward in Reading; and generally, if based upon some such principles as the foregoing scale, the marks obtained for Reading would be, on an average, approximately the same as those for Arithmetic. We might then infer that the one and same ability underlies both Arithmetic and Reading. If, however, the coefficient were only 0·50, the two would vary less closely together. A boy who in Reading was behind the average for his age by, let us say, 4 units, would in Arithmetic, be, on an average, only 0·50 (that is, half) of that amount behind, viz., 2 units. If the coefficient were zero, there would be no relation whatever between ability at the two subjects: from backwardness in Reading, no inference whatever could be made as regards backwardness in Arithmetic. If, finally, the coefficient were negative, then the boy who was backward in one would probably be advanced in the other.

Results.

The coefficients of correlation for the classes tested are given in Table XVIII. Each figure indicates the amount of correlation obtaining between the two subjects indicated in the heading at the top of its column and in the margin to the left of its row. Thus, ·71 measures the degree of resemblance between marks for Composition and marks for Science; ·65 measures the degree of resemblance between marks for Composition and marks for Arithmetical Problems; and so forth.

To possess any significance as evidence of correlation, a coefficient must be at least twice as large as its "probable error." With a group as large as the present, all coefficients over ·12 are twice as large as their probable errors; all coefficients over ·18 are three times as large. In Table XVIII. the coefficients fall below ·12 in only four cases out of 78. None are negative. Thus, so far as the present tests can be trusted, it appears that, *among individuals of an ordinary school class, ability in any one subject tends on the whole to be accompanied, to a greater or less degree, by ability in nearly every other subject.* The correspondence is never quite complete. It varies enormously with different pairs of subjects. But very rarely is it entirely absent.

TABLE XVIII.—CORRELATIONS BETWEEN SCHOOL SUBJECTS.

(A.) Observed Coefficients.

Data : special tests ; 120 children, aged 10— to 12— years ; 2 schools ; 3 classes, standards V and VI. (Reliability coefficients in brackets.)

	Composition.	Science.	Arithmetic (Problems).	Geography.	History.	Reading (Comprehension).	Dictation.	Writing (Speed).	Reading (Speed).	Handwork.	Arithmetic (Rules).	Drawing.	Writing (Quality).
Composition	(·76)	·71	·65	·70	·71	·58	·47	·50	·49	·30	·27	·38	·30
Science	·71	(·70)	·63	·65	·67	·51	·32	·38	·31	·49	·37	·19	·26
Arithmetic (Problems)...	·65	·63	(·81)	·51	·60	·49	·40	·22	·34	·38	·76	·21	·29
Geography	·70	·65	·51	(·72)	·71	·51	·45	·39	·38	·40	·25	·30	·22
History	·71	·67	·60	·71	(·78)	·57	·41	·32	·35	·31	·27	·28	·17
Reading(Comprehension)	·58	·51	·49	·51	·57	(·68)	·52	·21	·56	·10	·08	·15	·14
Dictation	·47	·32	40	·45	·41	·52	(·82)	·25	·38	·09	·31	·12	·18
Writing (Speed)	·50	·38	·22	·39	·32	·21	·25	(·80)	·35	·28	·32	·36	·30
Reading (Speed)... ...	·49	·31	·34	·38	·35	·56	·38	·35	(·79)	·19	·16	·15	·22
Handwork	·30	·49	·38	·40	·31	·10	·09	·28	·19	(·61)	·33	·50	·46
Arithmetic (Rules) ...	·27	·37	·76	·25	·27	·08	·31	·32	·16	·32	(·85)	·09	·18
Drawing	·38	·19	·21	·30	·28	·15	·12	·36	·15	·50	·09	(·54)	·57
Writing (Quality) ...	·30	·26	·29	·22	·17	·14	·18	·30	·22	·46	·18	·57	(·72)
Average	·50	·46	·46	·46	·45	·37	·33	·32	·32	·32	·28	·27	·27
Hypothetical General Factor	·85	·76	·76	·75	·74	·59	·52	·52	·52	·51	·45	·43	·43
General Educational Ability (·79)	·71	·55	·67	·58	·60	·64	·62	·43	·46	·37	·29	·24	·40
General Intelligence (·74)	·63	·56	·52	·35	·39	·51	·28	·48	·37	·50	·09	·17	·06

Reliability.

Each subject has been tested at least twice. The correlation of the first test with the second in the same subject is shown by the diagonal row of coefficients in brackets. These may be termed "reliability" coefficients. They indicate the reliability or consistency with which a given subject can be tested. On calculating this coefficient for ordinary school marks, it will not infrequently be found that the marks, particularly for such subjects as handwork and writing, refer to no single or consistant result whatever. (Dr. Carey's investigations, below, p. 61, admirably demonstrate the relative low reliability of school marks.) Clearly, a given kind of test or examination can only be considered trustworthy, if the second occasion on which it is carried out yields results distinctly resembling those obtained on the first occasion. A test, therefore, is only considered reliable if its "reliability coefficient" is above ·50. In the foregoing Table all the tests exhibit at least this amount of self-consistency.

Evidence of a Single Common Factor.

The correlations thus established between the several school subjects may legitimately be attributed to the presence of common factors. Thus, the fact that the test of Arithmetic (Problems) correlates highly with the test of Arithmetic (Rules) is most naturally explained by assuming that the same ability is common to both subjects; similarly, the correlation of Composition with Arithmetic (Problems) may be regarded as evidence of a common factor underlying this second pair; and so with each of the seventy-eight pairs. But is the common factor one and the same in each case? Or have we to recognise a multiplicity of common factors, each limited to small groups of school subjects?

To answer this question a simple criterion may be devised. It is a matter of simple arithmetic to reconstruct a table of seventy-eight coefficients so calculated that all the correlations are due to one factor and one only, common to all subjects, but shared by each in different degrees. Such a theoretical construction is given in Table XIX.[1] In this table theoretical values have been calculated so as to give the best possible fit to the values actually obtained in the investigation, and printed in Table XVIII. It will be seen that the theoretical coefficients exhibit a very characteristic arrangement. The values diminish progressively from above downwards and from right to left. Such an arrangement is termed a "hierarchy." Its presence forms a rough and useful criterion of the presence of a single general factor.

([1]) The figures for Tables XVIII. (hypothetical general factor), XIX. and XX. are obtained by employing the usual formula for 'multiple correlation'—

$$r_{12\cdot3} = \frac{r_{12} - r_{13}\cdot r_{23}}{(1 - r_{13}^2)^{\frac{1}{2}}(1 - r_{23}^2)^{\frac{1}{2}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \text{(i.)}$$

Thus, if the h.g.f. be the sole origin of correlations, the theoretical coefficients (Table XIX.) can be found at once by the following equation, which follows directly from (i.),—

$$r_{12} = r_{13}\cdot r_{23} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{(ii.)}$$

where r_{13}, r_{23} ≡ h.g.f. coefficients, 1 and 2 indicating any tests and 3 the h.g.f.

Again, if the specific correlations be treated as, in the long run, negligible, the h.g.f. coefficients (Table XVIII.) can be found by the following equation, which follows directly from (ii.),—

$$= \frac{a_1}{\sqrt{A}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{(iii.)}$$

where a_1 ≡ total (or average) of the entire row of observed coefficients for any test, 1, and A ≡ total (or average) of the coefficients in the whole table. In the case of the reliability coefficients, and certain other test-pairs (*cf.* Table XX.), the specific factors are not negligible. I have, therefore, assumed that the latter group neutralise each other on taking the table as a whole, and have omitted the reliability coefficients. This omission necessitates a slight, but obvious, complication in applying formula (iii.).

The specific correlations (Table XX.) merely require the use of equation (i.) in its original form.

The whole series of calculations is, of course, but provisional and tentative; and the results but first approximations.

TABLE XIX.—CORRELATIONS BETWEEN SCHOOL SUBJECTS.

(B.) Theoretical Values.

To illustrate the nature of a "hierarchy" constructed on the assumption of a sole and single factor, shared by all subjects in different degrees. Data: "Hypothetical General Factor" Coefficients of Table XVIII.

	Composition.	Science.	Arithmetic (Problems).	Geography.	History.	Reading (Comprehension).	Dictation.	Writing (Speed).	Reading (Speed).	Handwork.	Arithmetic (Rules).	Drawing.	Writing (Quality).
Composition	(·72)	·65	·65	·64	·63	·50	·44	·44	·44	·43	·38	·36	·36
Science	·65	(·58)	·58	·57	·56	·45	·39	·39	·39	·38	·34	·33	·33
Arithmetic (Problems)...	·65	·58	(·58)	·57	·56	·45	·39	·39	·39	·38	·34	·33	·33
Geography	·64	·57	·57	(·56)	·55	·44	·39	·39	·39	·38	·34	·32	·32
History	·63	·56	·56	·55	(·55)	·44	·38	·38	·38	·37	·33	·32	·32
Reading(Comprehension)	·50	·45	·45	·44	·44	(·35)	·31	·31	·31	·30	·26	·25	·25
Dictation	·44	·39	·39	·39	·38	·31	(·27)	·27	·27	·26	·23	·22	·22
Writing (Speed)... ...	·44	·39	·39	·39	·38	·31	·27	(·27)	·27	·26	·23	·22	·22
Reading (Speed)	·44	·39	·39	·39	·38	·31	·27	·27	(·27)	·26	·23	·22	·22
Handwork	·43	·38	·38	·38	·37	·30	·26	·26	·26	(·26)	·23	·22	·22
Arithmetic (Rules) ...	·38	·34	·34	·34	·33	·26	·23	·23	·23	·23	(·20)	·19	·19
Drawing	·36	·33	·33	·32	·32	·25	·22	·22	·22	·22	·19	(·18)	·18
Writing (Quality) ...	·36	·33	·33	·32	·32	·25	·22	·22	·22	·22	·19	·18	(·18)

On turning to the values originally obtained (Table XVIII.) it will be seen that they do, to some extent, conform to this criterion. In certain cases, however, the correlations are far too high—for instance, those between Arithmetic (Rules) and Arithmetic (Problems), and again Drawing and both Handwork and Writing (Quality). Now these instances are precisely those where we might anticipate special factors—general arithmetical ability, general manual dexterity—operating over and above the universal factor common to all subjects. These apparent exceptions, therefore, are not inconsistent with the general rule. Since, then, the chief deviations from the hierarchical arrangement occur precisely where, on other grounds, we should expect them to occur, we may accordingly conclude that *performances in all the subjects tested appear to be determined in varying degrees by a single common factor.*

Nature of the Common Factor.

What, then, is this common factor? The most obvious suggestions are that it is either (1) General Educational Ability, or (2) General Intelligence. For both these qualities, marks have been allotted by teachers, quite independently of the results of the tests. The correlations of these marks with performances in the tests are given in the last two lines of Table XVIII.

Upon certain assumptions, the correlation of each test with the Hypothetical Common Factor can readily be deduced from the coefficients originally observed.[1] These estimates are given in the last line but two of the table. They agree more closely with the observed correlations for General Educational Ability, especially if the latter are first corrected for unreliability. (Correlations: Hypothetical General Factor coefficients and General Educational Ability coefficients ·86, after correction ·84: Hypothetical General Factor coefficients and General Intelligence coefficients ·84, after correction ·77). *We may, therefore, identify this hypothetical general factor with General Educational Ability;* and conclude provisionally that this capacity more or less determines prowess in all school subjects.

The high agreement of the estimated coefficients with the intelligence correlations suggest that General Intelligence is an important, though not the only factor in General Educational Ability. Other important factors are probably long-distance memory, interest, and industry. It is doubtless not a pure intellectual capacity; and, though single, is not simple, but complex.

The test which appears to be most highly correlated with General Educational Ability, and indeed with every other subject is, Composition. We may, therefore, draw this inference. *Of all the single scholastic tests the one which gives the best estimate of General Educational Ability is an exercise in English Composition, set as a test of reasoning*—marked, that is, as the compositions in the present investigation were marked, not so much for writing, spelling, grammar, literary style, or general information, but rather for power of coherent logical thought. In organising school classes and in promoting children from one class to another, the test on which teachers often rely most strongly appears to be arithmetic. In the present investigation the arithmetical tests were of two kinds, one dealing with problems and the other with mechanical working of sums in the simple rules. The former is correlated very highly with General Educational Ability; the latter but little. Tests set by the teachers upon work done by the class examined too often approximate to the latter type; and, therefore, are, perhaps not always the best tests upon which to rely. But here, as in the testing of all

(1) See p. 53, footnote (1), equation (iii.).

mental abilities, *it is best to employ not one test but as many tests of as many different kinds as practical convenience will permit.*

Specific Educational Abilities.

We have noted that, in certain cases, over and above the resemblance due to General Educational Ability, there are additional resemblances attributable to special factors. For example, the resemblance between marks for the arithmetical tests cannot be attributed to the mere fact that General Educational Ability is required in both tests. Special arithmetical ability is also involved; and this raises the correlation above the coefficient of ·34 (which the influence of General Educational Ability alone would produce) up to a figure of ·76. What then are the chief special abilities affecting performances at school subjects? Is it possible to group certain subjects together as dependent upon similar capacities?

The practical importance of this question is evident. Suppose a department of children to be accurately organised into classes upon the basis of General Educational Ability. Then, as is clear from Table XVIII., each class will be homogeneously constituted, not merely as regards General Educational Ability, but also to a large extent as regards Composition, and perhaps as regards Arithmetic (Problems). It will not be so nearly homogeneous for Reading and Dictation. For Handwork, Drawing, Quality of Writing, and Mechanical Arithmetic, it will be fairly heterogenous; and will overlap considerably with classes next above and below.

Suppose, now, we reclassify the children according to ability in Handwork. Shall we then have fairly homogeneous, non-overlapping classes for Drawing, Quality of Writing, and Mechanical Arithmetic as well? *A priori* we might suspect that a re-classification adopted primarily for Handwork might avail also for Drawing and Quality of Writing; but we might doubt its suitability for purposes of Mechanical Arithmetic. Is empirical evidence accessible to verify these presumptions?

Specific Correlations.

For purposes of investigation this practical problem plainly resolves itself into the following theoretical enquiry: What special correlations would remain if we could eliminate the influence of General Educational Ability? This question can be attacked by means of the statistical method known as "multiple correlation."

I assume that the correlations of each subject with General Educational Ability may be approximately measured by the hypothetical general factor coefficients given in the last line but two of Table XVIII.; and, consequently, that the resemblance between performances in different subjects, due to the common presence of this factor, may be approximately measured by the theoretical coefficients given in Table XIX. The difference, therefore, between these theoretical coefficients and the observed coefficients based upon actual tests will provide the evidence for the presence of additional special factors. To obtain coefficients for the "specific correlations" these differences must be divided by an appropriate denominator in accordance with the usual formula for multiple correlation.[1]

The coefficients of special correlation thus obtained are given in Table XX. They may be taken as measuring the correlation that would be observed in a class where the General Educational Ability was throughout of the same level. In such a class it would be extremely difficult to predict the marks of a given child in, say, Arithmetic, from his marks in, say, Composition. The coefficients are now fewer and smaller. Out of 78 coefficients only 25 are significant.

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(1) See p. 53, footnote (1), equation (i.).

TABLE XX.—CORRELATIONS BETWEEN SCHOOL SUBJECTS.

(C.) Specific Correlations.

Data: Coefficients in Table XVIII.

	Composition.	History.	Geography.	Science.	Arithmetic (Problems.)	Arithmetic (Rules.)	Handwork.	Writing (Quality).	Drawing.	Writing (Speed).	Reading (Speed).	Dictation.	Reading (Comprehension).
Composition	...	·23	18	·18	·00	—·23	—·28	—·13	·04	·13	·10	·06	·19
History	·23	...	·37	·25	·09	—·10	—·10	—·25	—·07	—·10	·05	·05	·26
Geography	·18	·37	...	·19	—·14	—·14	·03	—·17	·03	·00	·02	·11	·13
Science	·18	·25	·19	...	·12	·05	·19	—·12	—·24	—·02	—·15	—·13	·11
Arithmetic (Problems)...	·00	·09	—·14	·12	...	·74	·00	—·07	—·20	—·31	—·09	·02	·08
Arithmetic (Rules) ...	—·23	—·10	—·14	·05	·74	...	·12	—·01	—·12	·12	—·09	·11	—·25
Handwork	—·28	—·10	·03	·19	·00	·12	...	·31	·36	·03	—·09	—·23	—·28
Writing (Quality) ...	—·13	—·25	—·17	—·12	—·07	—·01	·31	...	·48	·10	·00	—·05	—·15
Drawing	·04	—·07	·03	—·24	—·20	—·12	·36	·48	...	·18	—·09	—·13	—·14
Writing (Speed)	·13	—·10	·00	—·02	—·31	·12	·03	·10	·18	...	·11	—·03	—·14
Reading (Speed)... ...	·10	·05	·02	—·15	—·09	—·09	—·09	·00	—·09	·11	...	·15	·36
Dictation	·06	·05	·11	—·13	·02	·11	—·23	—·05	—·13	—·03	·15	...	·30
Reading(Comprehension)	·19	·26	·13	·11	·08	—·25	—·28	—·15	—·14	—·14	·36	·30	...

Negative Correlations between Special Subjects.

Nine of the significant coefficients are negative. Several are to be found under Quality of Writing. Apparently those who write fuller and better papers in Composition (and allied subjects) tend to scribble in a more hurried but less elegant hand than those whose answers are meagre and whose attention is directed rather towards elegance and neatness. This, however, only appears after the elimination of the effects of different General Educational Ability; otherwise, the children who are most able generally, will not only give better answers, but also write them in a better hand. There are also indications of a negative relationship between other manual abilities and certain literary subjects; and between certain literary subjects and Mechanical Arithmetic.

This analysis reconciles two popular views, which, as commonly stated, seem incompatible: first, the view that children who are intelligent at one or two important subjects will probably be intelligent at all; secondly, the view that children who are backward in subjects usually considered most important (Arithmetic, Reading, Composition) may yet excel in Handwork. Under certain conditions each belief is true.

In a group that is still fairly mixed as regards general ability, almost any test will, to some extent, sift out the more intelligent. Thus a scholarship examination in Arithmetic and Composition will probably pick out, not merely the good arithmeticians and the best writers of English Composition, but also those who are good all-round scholars. Indeed, if out of the remnants left behind by such an examination we endeavoured to select those who excel in manual work for, let us say, trade scholarships, we shall very probably find that many of the best manual workers have also already been taken. Similarly, in higher spheres, it may be possible to select men for administrative posts by examinations largely dealing with Greek and Latin history, philosophy, and verse.

If, however, we first eliminate the influence of differences in general ability, if, for instance, we consider a group whose educational intelligence as a whole is much the same throughout, then it is quite possible that children who are backward in the formal subjects of the school curriculum may excel in manual subjects; and children who excel in literary work may be relatively poor in arithmetical work. It should be remembered that the mere concentration of interest will of itself produce such negative relationships. A child who heads his class in Reading, Spelling, and Composition, and perhaps devotes much of his spare time to reading books and writing stories and letters, may consider manual work unworthy of serious effort or of leisure time. Conversely, a boy who has suddenly discovered he can really do something, let us say, in woodwork, may spend the time allotted to other subjects by dreaming, perhaps subconsciously, of what he will make in the hours for manual work.

Positive Correlations between Special Subjects.

The subjects which are positively correlated fall into three or four fairly distinct groups:

1. *An Arithmetical Group.*—The largest specific correlation obtains between the two arithmetical tests. These, therefore, are very closely allied; and probably test a special kind of ability.

2. *A Manual Group.*—Handwork, Drawing, Writing (Quality), and perhaps Writing (Speed) appear specifically correlated with one another. If anything, they are negatively correlated with Arithmetical Ability. The special ability underlying these is accordingly distinct from that underlying arithmetical activities.

3. *A Linguistic Group.*—Dictation, Reading (Comprehension), and Reading (Speed). These subjects also show no correlation with the arithmetical group and even negative correlations with the manual group. On the other hand, they appear not entirely unrelated to the Composition group, and with this, might perhaps be taken as forming a single Literary Group.

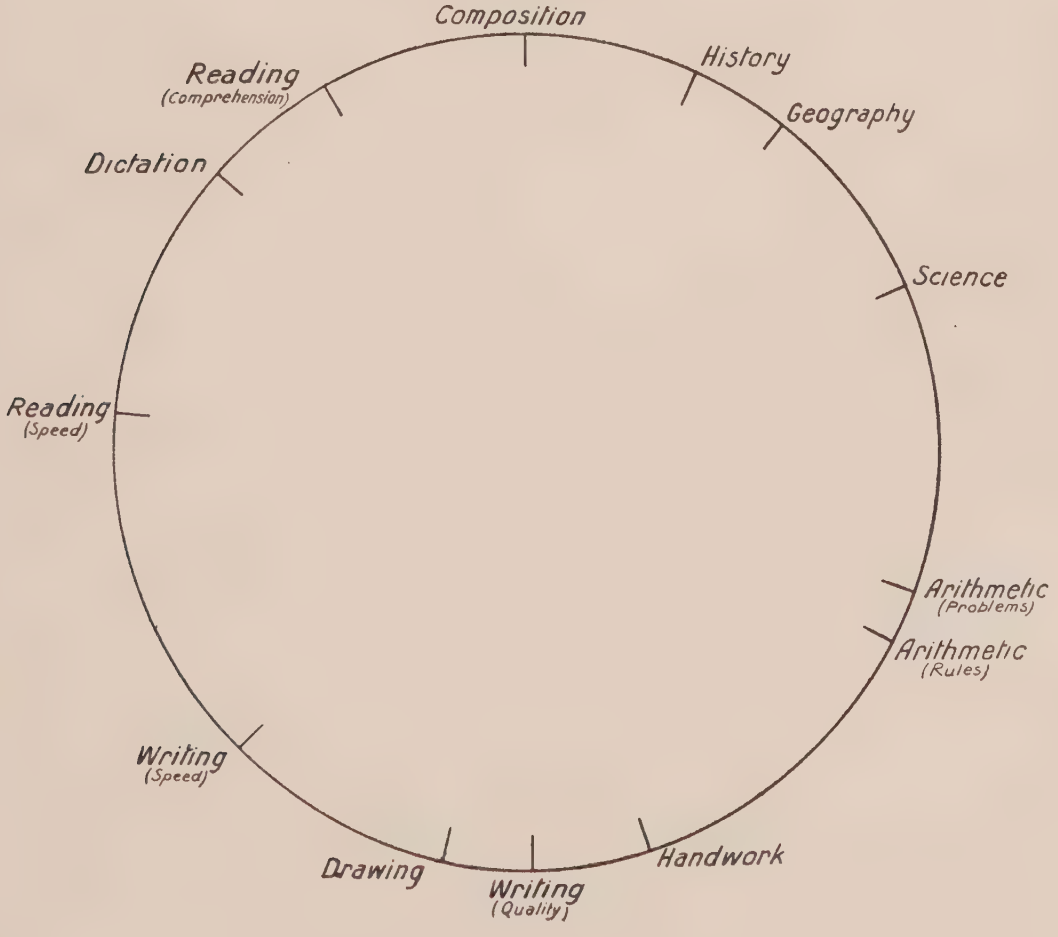
4. *A Composition Group.*—History, Geography, Science, and Composition appear closely related to each other, perhaps because the tests in the first three subjects, when set so as to exclude special knowledge, information or memory, tend to resolve themselves very largely into a series of brief compositions.

Cyclic Overlap.

It should be noted that the demarcation between the four groups does not appear very sharp. Science, for example, appears related both to the Composition group and to the Arithmetical group. Indeed it is possible to arrange the subjects in a series, so that each is correlated with the next, and the last with the first. The various capacities tested thus seem to form, as it were, a circular chain each linked to the next. It is tempting to infer that, by its choice of these subjects, the ordinary school curriculum views scholastic ability from almost every side. Such a conclusion, however, is too fanciful. But there can be little doubt that the special abilities, involved in the various groups of subjects, to some extent overlap. Both the overlap and the grouping of subjects is illustrated in the "clock-diagram" above (Figure 8). In the diagram subjects most closely related

FIGURE 8.

To illustrate the Specific Relations between the Chief Subjects of the School Curriculum.



are placed next to one another; and their proximity, measured along the circumference of the circle, is proportional to the closeness of their relation.[1] The overlap would be rendered more complete by using tests or teaching-methods, which would co-relate the several groups of subjects more closely, and so link up the corresponding mental abilities.

Confirmation by other Investigations.

The results here described have been obtained by examining the very small number of children to which a single investigator, making careful personal tests, is necessarily confined. The two main conclusions, however, agree with inferences already drawn by Mr. Moore and myself from experiments upon Liverpool school children; and may, I think, be discerned in two independent surveys based upon school marks, carried out by Dr. Carey and Mr. Bradford, assistant teachers in the service of the Council.

Mr. Bradford has tested 224 children, ages $9\frac{1}{2}$ to $13\frac{1}{2}$ years. The correlations between the various school subjects considered are given in Table XXI. It will be seen that Composition correlates most with the other subjects, and Arithmetic least, and that all the correlations are positive. Mr. Bradford has further endeavoured to analyse the special nature of the mental abilities concerned by means of special psychological tests. He infers that mechanical memory is a factor common to the five school subjects; that verbal memory forms a special factor common to

TABLE XXI.—CORRELATIONS BETWEEN SCHOOL SUBJECTS.

Data: school marks, 224 children, aged $9\frac{1}{2}$ to $13\frac{1}{2}$ years.
(Mr. Bradford's Investigation.)

	Composition.	Spelling.	Reading.	Arithmetic.	Writing.
Composition	...	·44	·50	·32	·19
Spelling	·44	...	·44	·25	·22
Reading	·50	·44	...	·13	·19
Arithmetic	·32	·25	·13	...	·08
Writing	·19	·22	·19	·08	...
Average	·36	·34	·32	·19	·17

(1) The existence of "cyclic overlap" makes it difficult to demonstrate the presence of a hypothetical general factor and to calculate more precisely the h.g.f. coefficients. In the first place, such overlap may obviously produce the semblance of a hierarchy, if only the overlap is sufficiently complex and systematic. In the second place we cannot now omit specifically correlated pairs of subjects, in order to re-calculate the h.g.f. coefficients to a closer approximation; for every subject seems correlated specifically with its immediate neighbours. The best corroboration, therefore, lies in the correspondence of the calculated h.g.f. coefficients with the empirical correlations for general educational ability; and in the correspondence of the specific correlations with common expectation.

I have drawn attention to these difficulties, when first noting the existence of cyclic overlap in an attempt to establish a general factor underlying the primary emotions. (*Brit. Ass. Reports* Manchester, 1915, Sub-section I.) The nature of cyclic overlap, however, is more clearly understood by considering the results of experiments with the same test repeated daily. Here Monday's marks, for example, will be found to correlate most closely with Tuesday's, Tuesday's with Wednesday's, and so on, each day correlating especially with its neighbours, until the second Monday is reached, when a high correlation with the first Monday is commonly found. The test is the same throughout. Hence, a general factor must be operating. Yet its presence would be difficult to demonstrate by means of a "hierarchy." The reader, therefore, must be warned that, to some minds, not only the existence, but even the method of proving a general factor remains a matter for dispute.

Reading, Spelling, and Composition; and motor co-ordination is an important factor in Writing and kindred manual operations; and that "visuo-kinæsthetic" imagery (pictorial imagery and imagery for movements) is a factor in arithmetical ability.

Dr. Carey has collected the examination marks for about 600 children, aged 7 to 14 years, from the senior departments of four ordinary elementary schools under the Council. The correlations obtained, corrected as far as possible for the unreliability of marking, are given in Table XXII. Owing to the low reliability found on using school marks, especially in such subjects as Writing and Needlework, the number of children differs in different subjects. In the Table, the reliability coefficients for these subjects appear high only because classes where the marks proved unreliable (reliability coefficients below ·50) were rejected. The figures distinctly suggest a hierarchical arrangement, but there are marked deviations. Dr. Carey concludes that here the children's performances are due to (1) a general factor, such as general intelligence; (2) a large specific factor, namely, motor ability, affecting Writing, Painting and Needlework; (3) a smaller factor, which she considers to underlie Reading, Composition, and Spelling, and which she identifies with "the association between written words and their meanings."

TABLE XXII.—CORRELATIONS BETWEEN SCHOOL SUBJECTS.

(A.) Observed Correlations (Corrected for "Unreliability").

Data: school marks, 600 children, aged 7 to 14 years; 4 schools.
(Dr. Carey's Investigation.)

	Geography.	Composition.	Science	History	Arithmetic.	Reading.	Spelling.	Writing.	Painting.	Needlework.
Geography ...	(·55)	·73	·84	·88	·65	·62	·53	·40	·32	·52
Composition	·73	(·73)	·69	·68	·62	·64	·75	·48	·42	·27
Science ...	·84	·69	(·60)	·75	·63	·57	·43	·34	·44	·48
History ...	·88	·68	·75	(·56)	·67	·66	·44	·27	·17	·22
Arithmetic ...	·65	·62	·63	·67	(·69)	·46	·52	·39	·41	·37
Reading ...	·62	·64	·57	·66	·46	(·74)	·79	·36	·28	·12
Spelling ...	·53	·75	·43	·44	·52	·79	(·74)	·40	·24	·17
Writing ...	·40	·48	·34	·27	·39	·36	·40	(·70)	·52	·54
Painting ...	·32	·42	·44	·17	·41	·28	·24	·52	(·72)	·52
Needlework	·52	·27	·48	·22	·37	·12	·17	·54	·52	(·67)
Average ...	·61	·59	·57	·53	·52	·50	·47	·41	·37	·36
Hypothetical general factor	·88	·86	·83	·75	·75	·70	·66	·57	·51	·49

I have calculated the averages, the correlations with the hypothetical general factor (Table XXII.) and the specific correlations (Table XXIII.), for Dr. Carey's data, upon the same lines as before. It will be observed that Composition again shows an extremely high average correlation with the other subjects, and an extremely high correlation with the hypothetical general factor. There is, however, no independent evidence that the hypothetical general factor corresponds with General Educational Ability,

except *a priori* probability, and the general agreement of the order with that found in my own investigation. Hence, my estimates of the specific correlation (Table XXIII.) are here not very trustworthy. They agree, however, very largely with those based upon actual tests. Further, as before, there is discernible a tendency both to grouping and to cyclic overlap.

TABLE XXIII.—CORRELATIONS BETWEEN SCHOOL SUBJECTS.

(B.) Specific Correlations.

Data : Coefficients in Table XXII.

	Geography.	Science	Arithmetic.	History	Reading.	Composition.	Spelling.	Writing	Painting.	Needlework.
Geography ...	...	·42	—·03	·71	·00	—·08	—·14	—·26	—·32	·22
Science ...	·42	...	·03	·35	—·03	—·07	—·29	—·28	·04	·14
Arithmetic ...	—·03	·03	...	·24	—·13	—·06	·06	—·08	·05	·00
History ..	·71	·35	·24	...	·30	·12	—·10	—·30	—·37	—·26
Reading ...	·00	—·03	—·13	·30	...	·13	·62	—·07	—·17	—·35
Composition	—·08	—·07	—·06	·12	·13	...	·47	·00	—·02	—·33
Spelling ...	—·14	—·29	·06	—·10	·62	·47	...	·04	—·16	—·23
Writing ...	—·26	—·28	—·08	—·30	—·07	·00	·04	...	·33	·37
Painting ...	—·32	·04	·05	—·37	—·17	—·02	—·16	·33	...	·36
Needlework...	·22	·14	·00	—·26	—·35	—·33	—·23	·37	·36	...

Dr. Carey has also attempted an analysis of the specific factors in the scholastic work of elementary school children, more particularly as regards the nature of the imagery involved. She finds that, with current methods of teaching, auditory and auditori-motor imagery is of more importance than visual, especially in those subjects which are most often learnt through the ear,—history, science, and geography. But she concludes that such subjects would be better remembered if greater emphasis were laid upon visual presentation.[1]

Nature of Special Scholastic Abilities.

To analyse the psychological nature of scholastic abilities, several prolonged investigations have been undertaken, with the co-operation of school teachers, following for the most part the lines of analysis already employed upon the same problem with the assistance of school teachers at Liverpool, and already described in earlier publications. A provisional survey of the

(1) I have to acknowledge my indebtedness to Mr. Bradford and to Dr. Carey for allowing me to refer to their data, which have been gathered for investigations carried out with the generous assistance of Dr. Brown, at the Psychological Laboratory, King's College, and of Professor Spearman, at the Psychological Laboratory University College.

results so far obtained suggests the following conclusions: First, the abilities and processes involved are far more complex than those who have written upon this subject commonly assume. Secondly, similar results are reached by different children by very different mental processes; consequently, a child who fails under one method of instruction will often succeed, if a brief study be made of his natural aptitudes and operations and another mode of instruction adopted accordingly. Thirdly, similar subjects require very different abilities at different ages and at different stages of progress. Thus, subjects which, in standards V. and VI., involve comparatively mechanical operations—such as Dictation and Arithmetic (Rules)—may, in standards II. and III., require mental powers of quite a different order. Indeed, in lower standards, such subjects tend to show a correlation with General Educational Ability far higher than is found in higher standards. Except, therefore, for rough preliminary surveys, it would be a mistake to throw together marks and correlations for different standards and ages into a single table; and the statements made above as regards the grouping of special subjects strictly apply only to children of the level tested, namely, standards V. and VI. Indeed, it was for this reason that the more elaborate experiments were in the first instance confined to children of these classes.

Correlations between Educational Abilities among Defectives.

The correlations between attainments in different school subjects among a group of high-grade mentally deficient children are given in Table XXIV. The coefficients are not high and show no clear hierarchical arrangement. Certain fundamental school subjects,—Arithmetic, Reading and Dictation,—appear somewhat closely associated, and form, perhaps, a "Scholastic" group; other more special subjects,—Handwork, Drawing,—are similarly associated, and may perhaps indicate a "Manual" group. Among defectives, therefore, the distribution of capacity appears to be somewhat more uneven than among normal children. There is less evidence for the assumption that educational ability may be treated as a single mental quality. Such treatment can at present be justified only upon grounds of simplicity and convenience. This conclusion, however, is entirely consistent with what I have elsewhere remarked as to the complexity and ambiguity of the current conception of "mental deficiency." For practical purposes, it suggests *the importance of further classifying cases of deficiency according to the kind of deficiency, as well as according to its degree.* Some defectives excel in manual subjects, but are unable to master intelligent reading, writing, or calculation; others may so profit by instruction in these latter subjects as eventually to become fit for re-transference to the ordinary schools; others may be afflicted with special defects—such as those described as "word-blindness" or "number defect"; others, again, may be unable to acquire manual dexterity or to use tools with safety or skill. These different types should be sorted out in an observation class, and eventually transferred to classes specially suited to their special kind of ability or defect.

A more detailed analysis is urgently needed for the particular kinds of mental ability and deficiency occurring among defectives. Unfortunately, however, the simple method of merely correlating the results of a few scholastic tests is with them inadequate. The children's ability varies considerably from day to day. Hence, as may be seen from the table, the "reliability" of estimates and measurements thus obtained is not high. Further, defectives already form a selected group, chosen very largely on the ground of ability or disability in school subjects; and it is difficult to find, for experimental purposes, a group or class, fairly homogeneous in all respects

except those mental qualities it is proposed to study. For these reasons, correlations between the performances of defectives are bound to be somewhat low and irregular. What is needed is a prolonged study of individuals by teachers who are able to observe them closely from day to day and from year to year.

TABLE XXIV.—CORRELATIONS BETWEEN SCHOOL SUBJECTS.

Special (M.D.) School Children.

Data : scholastic tests and teachers' estimates for 73 mental defectives (high grade) aged 10— to 15— years.

	Arithmetic (Rules).	Reading (Comprehension).	Reading (Speed).	Dictation.	Handwork.	Drawing.	Writing (Quality).	Writing (Speed).
Arithmetic (Rules)	(·55)	·53	·31	·33	·45	·13	·36	·32
Reading (Comprehension)	·53	(·59)	·69	·41	·16	·29	·13	·18
Reading (Speed)	·31	·69	(·62)	·45	·31	·28	·05	·52
Dictation ...	·33	·41	·45	(·68)	·29	·12	·28	·35
Handwork ...	·45	·16	·31	·29	(·66)	·43	·38	·24
Drawing ...	·13	·29	·28	·12	·43	(·53)	·44	·37
Writing (Quality)	·36	·13	·05	·28	·38	·44	(·49)	·48
Writing ...	·32	·18	·32	·35	·24	·37	·48	(·54)
General Educational Ability.	·61	·59	·53	·57	·45	·36	·33	·21
General Intelligence...	·57	·62	·34	·51	·55	·28	·32	·39

Conclusion.

The main conclusion, then, to be drawn from the foregoing tables of correlations is this: *School achievements are due to mental qualities of two kinds: first, a general ability entering into all school work; secondly, special aptitudes for particular subjects.*[1]

These preliminary investigations furnish certain tentative suggestions of practical interest. They are concerned, for the most part, with methods of observing, recording, or classifying individuals, first, as members of a given type, secondly, as members of a given sex or social class, and finally as members of a given age-group, school-class, or school.

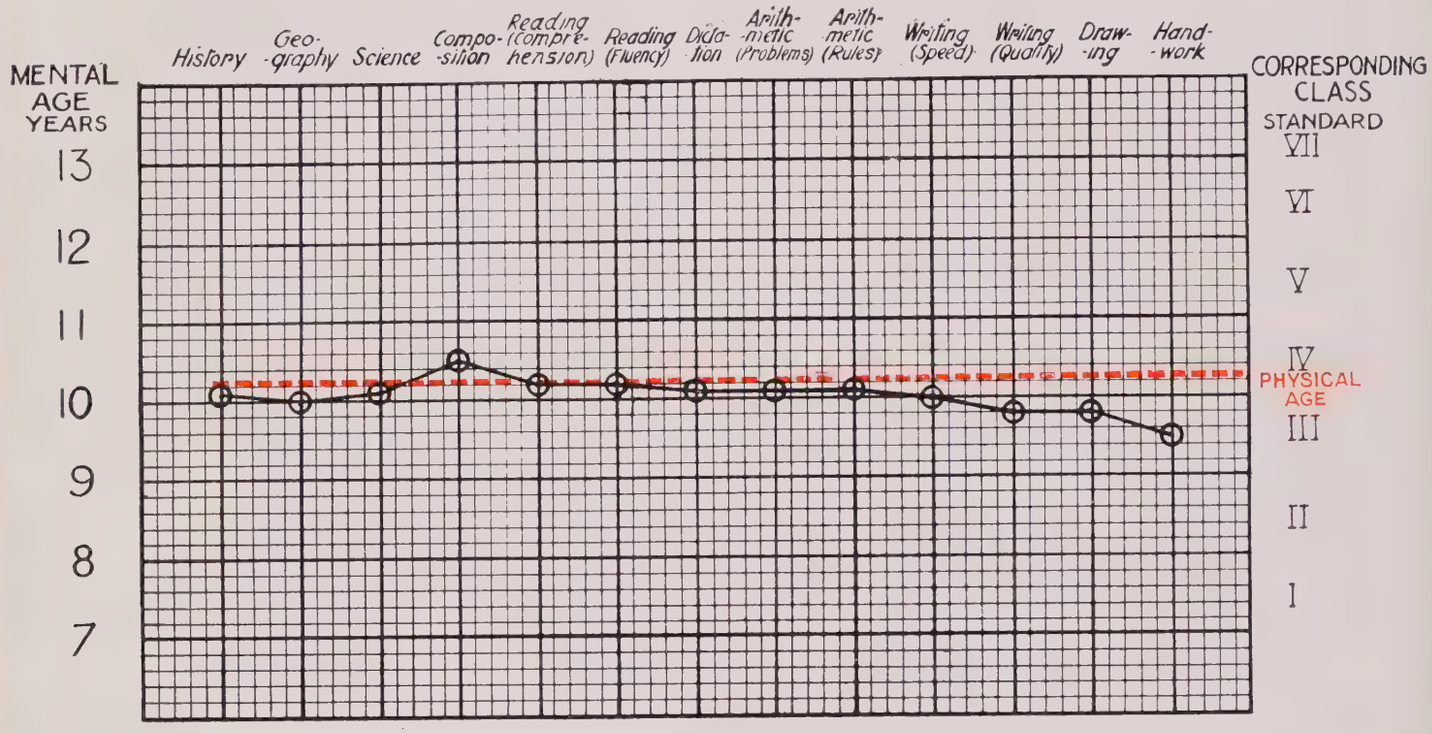
(1) For a further discussion of this distinction I may perhaps refer to my address to the Manchester Child Study Society (1909), reprinted in *Child Study*, Vol. IV., Nos. 2 and 3 esp. pp. 94-5

PSYCHOGRAPHS FOR SPE

1. 'MEDIUM' GENERAL ABILITY:

SPECIAL ABILITIES EVENLY DEVELOPED.

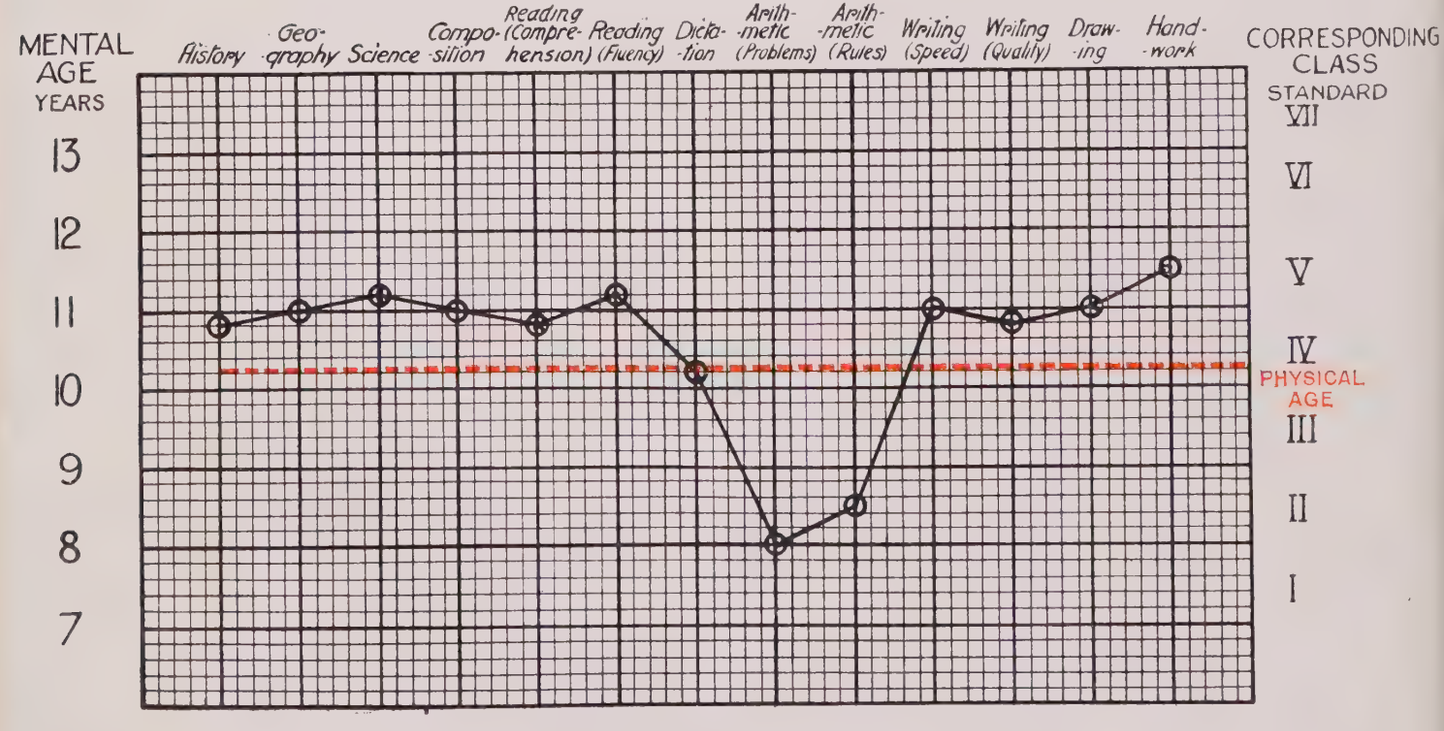
BOY, AGED 10 2/12, STANDARD Vb



2. 'FAIR' GENERAL ABILITY:

SPECIAL DEFECT IN ARITHMETIC.

GIRL, AGED 10 2/12, STANDARD Vb.



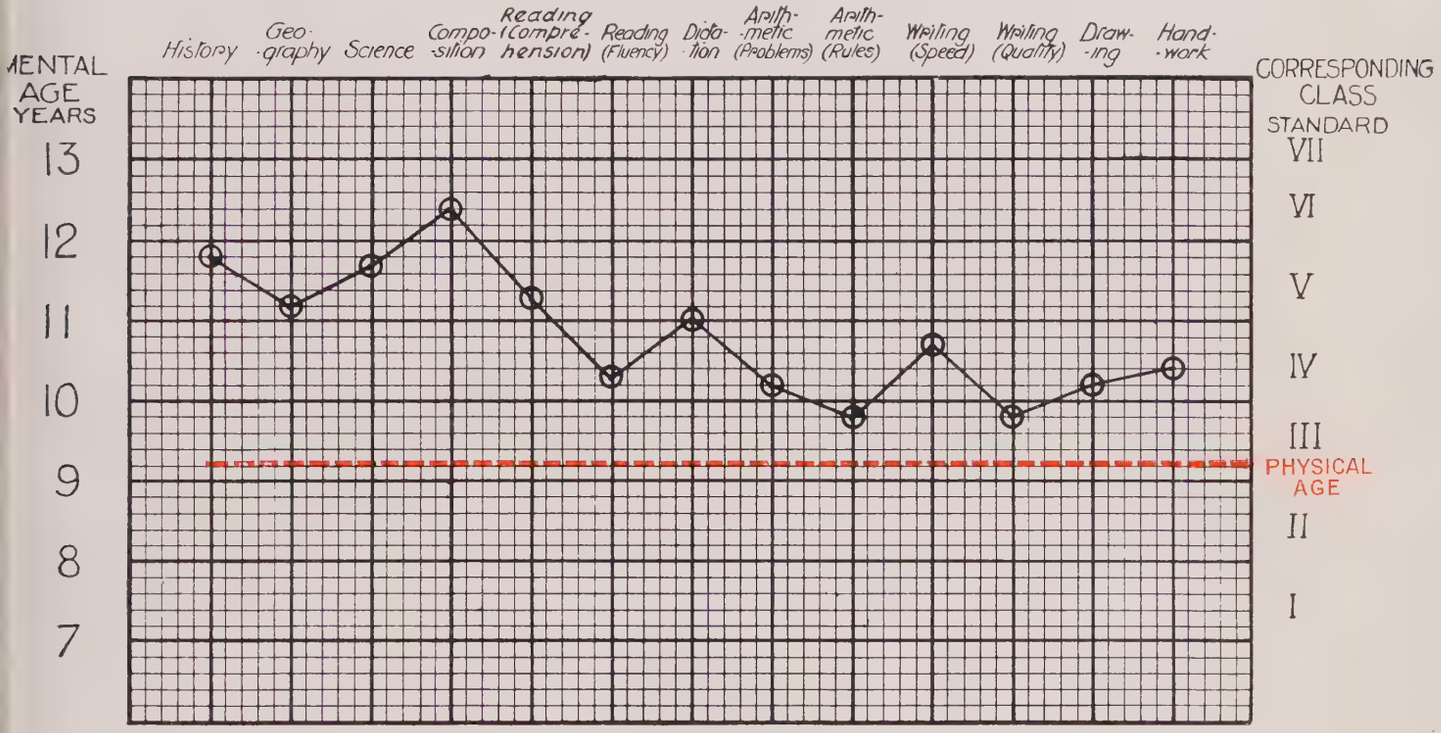
(Between pp. 64 and 65.)

EDUCATIONAL ABILITIES.

3. 'VERY FAIR' GENERAL ABILITY:

SPECIAL ABILITY IN COMPOSITION.

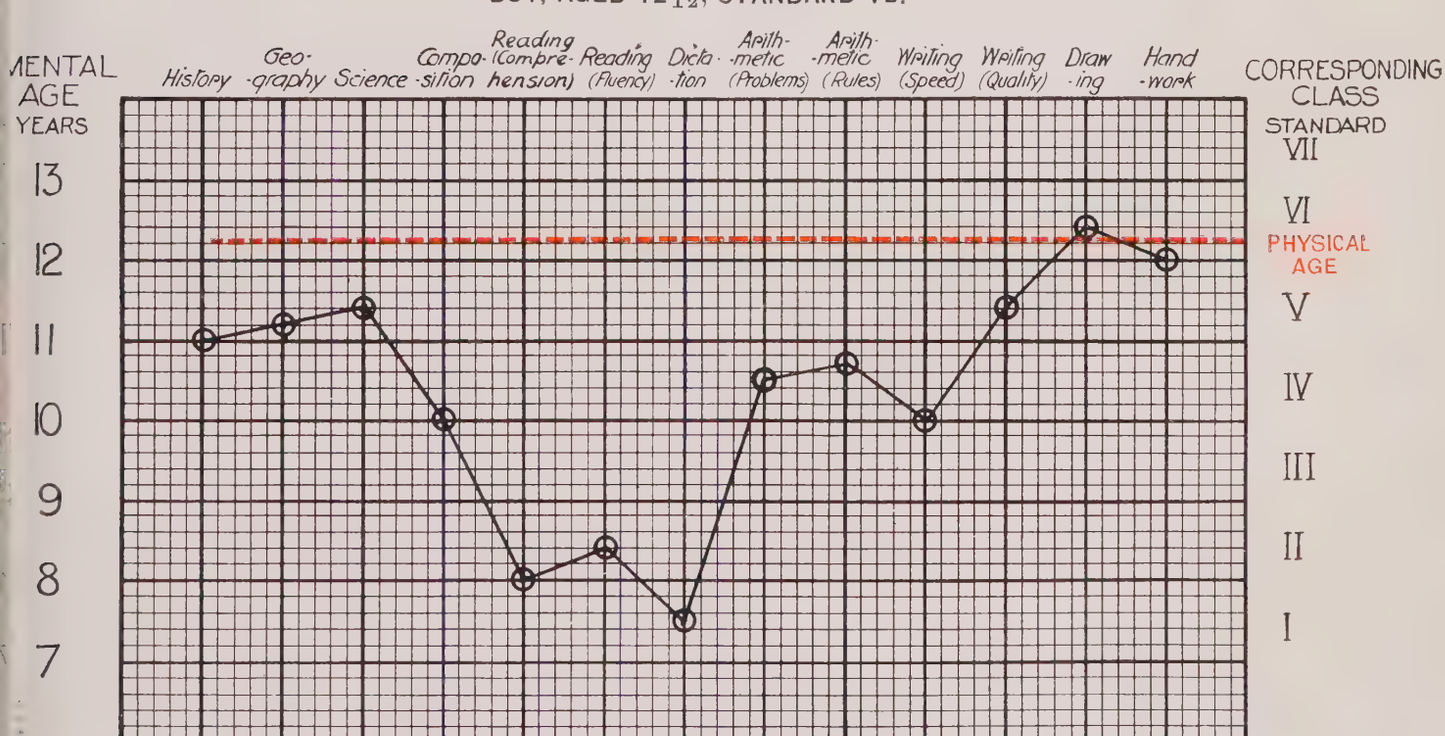
GIRL, AGED 9 $\frac{3}{12}$, STANDARD Vb.



4. 'VERY POOR' GENERAL ABILITY:

SPECIAL LINGUISTIC DEFECT.

BOY, AGED 12 $\frac{2}{12}$, STANDARD Vb.



Psychographs for Individual Children.

In order to study and compare the peculiar endowments and deficiencies of individual children some simple plan is needed for recording the degrees of such general and specific abilities in diagrammatic form. For this purpose, I have elsewhere suggested what may be termed scholastic " psychographs." These are obtained by plotting upon a uniform scale in a uniform order the child's mental level in each of the chief school subjects. Illustrations for the more important types are given in Figure 9. The first is the psychograph for a child of normal ability in all subjects of the curriculum. Were all children of this type, the correlations between school tests would be peculiarly high; and the organisation of school classes a simple and straightforward thing. The second psychograph represents the not uncommon case of special arithmetical deficiency; the third, a case of special ability in work involving composition; the fourth, a case of special defect in linguistic subjects—reading, spelling, etc.—somewhat resembling so-called congenital " word-blindness."

The latter cases tend to reduce the correlations between scholastic tests; and make it difficult always to classify once only for all school subjects. The graphed records yield a clear picture of the educational capacities of such individuals; and after a number have been thus analysed, show at a glance the type to which each individual belongs. In practical work they have already proved extremely helpful for keeping diagrammatic summaries of the special characteristics of individual children.

Sex Differences.

Ability in particular school subjects appears to differ in the two sexes. Boys apparently excel in Arithmetic, especially Arithmetical Problems, in Drawing, and probably most of the other manual subjects, that are commonly taught to both sexes. Girls excel in Linguistic subjects (especially in fluency of Reading), in subjects depending upon Composition (especially in the literary aspects of Composition), and in speed and quality of Writing. My data, however, do not enable me to conclude with certainty as to the precise nature or extent of these differences, much less as to how far they are due to the peculiarities of sex-heredity, sex-tradition, or departmental teaching. Observations already commenced in a mixed school may perhaps throw light upon this problem.

Social Differences.

Among the ordinary elementary schools where the children were tested throughout were included (1) a school attended by children from the poorest homes in the borough, (2) a school where the home circumstances were better than for any other school, and (3) a school where the home circumstances differed very considerably with different individuals. A comparison of the performances suggests the following inferences. The children from better homes excel, to the greatest extent and with the greatest frequency, in Composition; they excel nearly as often and nearly as much in Arithmetic (Problems) and Reading; they excel very frequently, but not invariably, in Spelling and Mechanical Arithmetic; they excel little, if at all, in Manual subjects. In Composition, Reading, and Arithmetic, schools or groups drawn from the poorest homes may be 9 to 12 months behind those drawn from the best. Illustrative figures have been published elsewhere; but a far wider enquiry needs to be carried out before the problem can be discussed in detail, and the causes,—hereditary, economic, and social,—can be evaluated. Here, indeed, lies a most urgent field for research.

Heterogeneity and Overlap in Special School Subjects.

Ability in certain subjects is, we have seen, determined largely by special aptitude; and attainment in such subjects is very incompletely correlated with attainment in the rest. In consequence of this, schools and classes organised on the basis of General Educational Ability will prove extremely heterogeneous as regards subjects where the correlation with General Educational Ability is but slight; and, in these at any rate, each class will very largely overlap with the rest.

In order to study the heterogeneity and overlap we need tests which can be carried out in the same way with all ages and all classes, and marked in some simple quantitative fashion. For this purpose, the most convenient tests are exercises in Mechanical Arithmetic and in Dictation. The same sums and the same sentences can be set to all; and excellence can readily be measured in terms of the number of figures, or words or letters, correctly written down. Typical schools were chosen for examination in these two subjects. Other subjects were also tested; but, with these, a marking applicable to all ages and classes involves somewhat technical methods that destroy the illustrative value of the results. Accordingly, to avoid a lengthy analysis, I give figures for but two tests at one school. The school selected is that considered by the district inspector to be approximately median for the borough.

Heterogeneity of Age-groups and of Actual and Ideal School Classes.

The best measure of the heterogeneity of a class or age-group is its "standard deviation." For comparative purposes, however, the ratio of the standard deviation to the average of the group ("coefficient of variation") is often preferable. In illustration I give averages, standard deviations and coefficients of variation for Mechanical Arithmetic (Tables XXV. and XXVI.). The unit of measurement throughout is the number of correct operations (approximately, correct figures in the answer) worked in 20 minutes.[1] Table XXV. gives values for the several age-groups. For the various ages, the standard deviation varies from about 20 to about 50. On an average, it is about 40 per cent. of the average for the age-group. In the classes, the standard deviation is much smaller. Table XXVI. gives values (1) for the classes as actually constituted ("observed values"), (2) for imaginary classes composed of the same numbers, and formed so that there is no overlap whatever ("theoretical values"): the worst 50 have been selected for the lowest class, the next worst 50 for the next class above, and so on. In the classes as actually formed, the standard deviation varies from about 12 to between 30 and 40. It is about 27 per cent. of the average. By reclassifying the children specifically for ability in Mechanical Arithmetic instead of for educational ability generally, the standard deviations are still further reduced. The "theoretical" values for such ideal classes vary for the most part between 4 and 6, and are about 7 per cent. of the average. Similar results are obtained with the other tests. The actual figures are greatly affected by the unit of measurement; and the allowances are too speculative and elaborate to be discussed here. Generally speaking, in single subjects, individuals seem to vary, on an average,[2] from 20 to 50 per cent. on either

(1) The tests used were those described in detail by Dr. Ballard in the *Journal of Experimental Pedagogy*, Vol. II., No. vi., p. 396. The sums were worked upon printed sheets. The instructions were given, and the supervision and marking carried out, by me personally.

(2) As before the term "average" is used somewhat loosely to save technical circumlocution. The measure of deviation in view is a "root-mean-square," not a "mean," or strict average.

side of the mean for the age-group: from 10 to 30 per cent. on either side of the mean for their class: but only from 3 up to about 15 per cent. on either side of the mean with the most homogeneous class that could be formed by classifying specifically for the subject under consideration.

If we amalgamate the marks for the different subjects, heterogeneity appears to be somewhat less. The tables are too numerous and complicated for publication here. *Roughly speaking, for age-groups in the middle of the school career, the standard deviation in the totals for all subjects tends to be about the same as the difference between the averages for two consecutive age-groups.* This is a similar result to that reached from other data in the foregoing memorandum. If anything, the degree of variation was somewhat minimised by the latter. *By the ordinary methods of school organisation the variation of a class is reduced to about one-half that of an age-group. By an ideal classification for each subject separately, it could theoretically be reduced to about one-third.*

TABLE XXV.—MECHANICAL ARITHMETIC.

(A.) Heterogeneity of Age-groups.

Averages, Standard Deviations, and Coefficients of Variations for the several ages.

Age.	Average.	Standard deviation.	Coefficient of Variation.
7 – years	(7·6)	(8·6)	(113·2)
8 – „	22·7	22·1	(97·4)
9 – „	57·0	32·6	57·2
10 – „	97·6	46·0	47·1
11 – „	111·8	40·1	35·9
12 – „	126·0	39·0	30·9
13 – „	142·3	51·3	36·2

TABLE XXVI.—MECHANICAL ARITHMETIC.

(B.) Heterogeneity of Classes.

Averages, Standard Deviations and Coefficients of Variation for Actual and Ideal Classes.

Class.	Observed Values.			Theoretical Values.		
	Average.	Standard Deviation.	Coefficient of Variation.	Average.	Standard Deviation.	Coefficient of Variation.
Standard I ...	2·9	(2·8)	(96·6)	1·9	(1·4)	(73·7)
Standard II ...	14·0	12·5	(89·3)	11·1	4·6	(41·4)
Standard IIIB ...	31·0	14·9	(48·1)	29·1	5·1	(17·5)
Standard IIIA ...	53·2	15·0	28·2	46·7	5·9	12·6
Standard IV ...	61·8	22·6	36·6	66·9	5·7	8·5
Standard VB ...	116·6	32·6	28·0	90·9	6·9	7·6
Standard VA ...	116·3	26·6	22·9	109·1	5·7	5·2
Standard VIB ...	132·1	30·4	23·0	126·3	4·3	3·4
Standard VIA ...	126·1	37·0	29·3	139·0	3·9	2·8
Standard VIIB ...	124·3	28·2	22·7	155·0	6·3	4·1
Standard VIIA ...	171·8	48·8	28·4	203·1	22·2	(10·9)

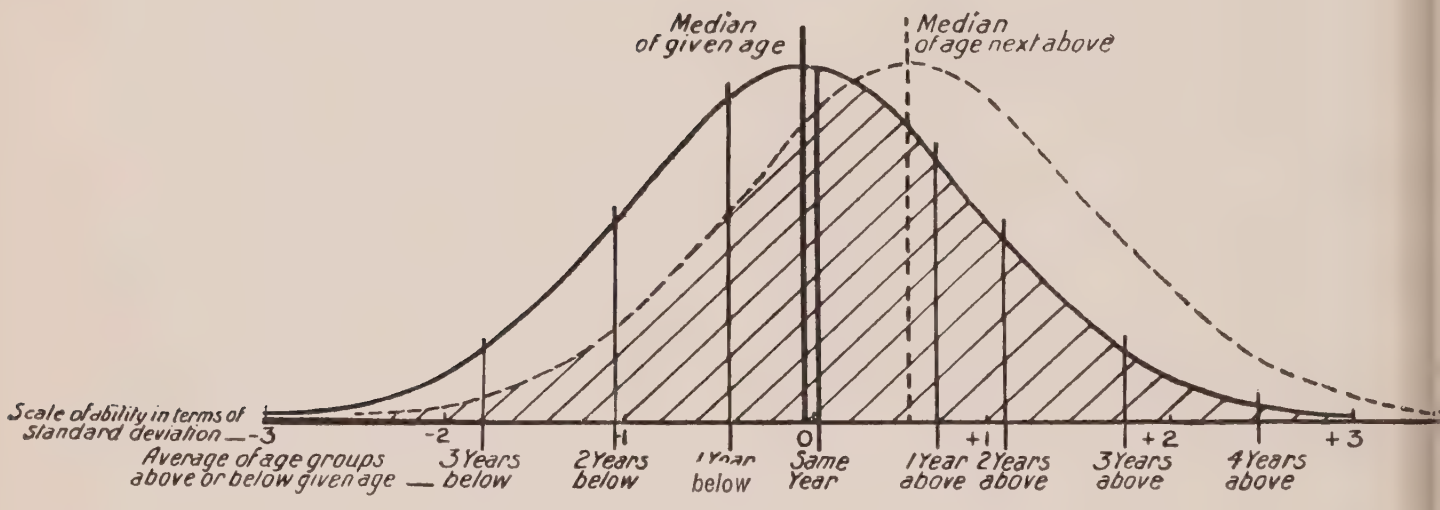
Overlapping of Age-groups.

I shall consider first, and in greatest detail, the results for Mechanical Arithmetic. The distributions of ability for the several classes are shown in Figure 11. These illustrate in concrete form the abstract statements already made in regard to heterogeneity. It will be seen that there is a vast amount of difference between individuals, especially among those comprising the higher age-groups. The worst children aged thirteen are

FIGURE 10.

OVERLAPPING OF AGES.

(Mechanical Arithmetic.)



weaker than the best child aged eight. The children aged nine and the children aged ten both cover a far wider range than the averages for all the seven age-groups. Such diagrams, therefore, show very clearly how rough and approximate, in the case of school subjects, is the notion of a "mental age." *Averages and norms for various ages can have very little significance, unless accompanied by some measure of deviation.*

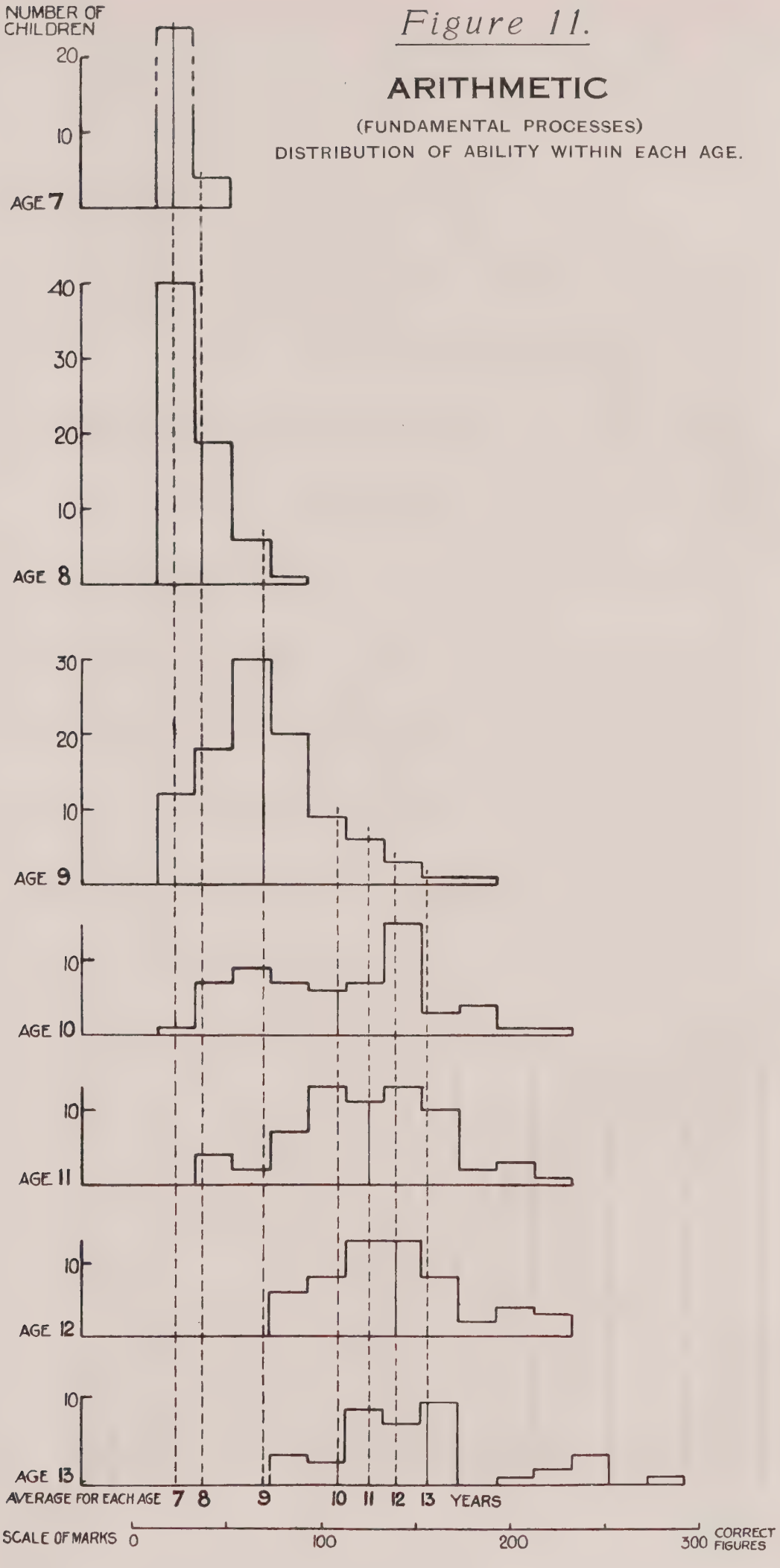
In order that the general amount of overlap may be visible at a glance, the various distributions have been amalgamated and smoothed by a process of averaging. The average overlap in Mechanical Arithmetic, for any two adjacent age-groups thus obtained, is represented in Figure 10.

The method of averaging employed is shown in Table XXVII. From the average percentages in the last line of the table the average differences between the averages for each age can be computed in terms of the standard deviation of a normal group. These are shown by the fine vertical lines in Figure 10. The curve (continuous line) for the given age is drawn about the median, not about the average. The median for the second curve in the figure (interrupted lines) in then found by averaging the differences between the average of the given age and both the average of the age above and that of the age below.

Figure 11.

ARITHMETIC

(FUNDAMENTAL PROCESSES)
DISTRIBUTION OF ABILITY WITHIN EACH AGE.



(To face p. 68.)

To measure the general degree of overlapping we need some simple equation or formula. The area shaded in the figure would naturally be taken as indicating the amount of overlap. If we assume that both curves are normal, and have the same standard deviation, this area can readily be estimated. We have merely to find the difference between the two medians, halve it, find from a table of values for the normal probability integral the percentage of the whole area falling beyond this midpoint, and double it. Accordingly, twice the percentage of either group, which falls beyond the point midway between the medians of the two groups, may be taken as the measure of overlap.[1]

If the overlap is complete, the figure thus calculated will clearly be 100 per cent. If there is no overlap, then with age-groups or classes of about 50 children, the figure should be under 1 per cent., and the distance between the two medians, therefore, at least 4·6 S.D.

In Mechanical Arithmetic the average difference between the medians for any two adjacent age-groups is 0·57 S.D. This yields 76·6 per cent. as the measure of average overlap. Thus, three-eighths of the lower age-group surpass, three-eighths of the higher age-group fall below, the ideal line of division between the two groups. *About twenty-three per cent. of the children of a given age are better than the average of the next age above, and nearly thirty-four per cent. are worse than the average of the age next below.* Some are even better than the average of children two or three years older.

The overlap in other subjects is nearly as marked. It is greatest in those subjects where achievement is determined (or left to be determined) chiefly by inborn aptitude—for instance, in drawing and manual work. It is least in those subjects which depend upon progressive accumulation year by year of acquired information—for instance, knowledge of history and geography.

To obtain measures for General Educational Ability, the marks for all the school subjects, each weighted according to its correlation with the "hypothetical general factor," must first be amalgamated. The average amount of overlapping between any two consecutive ages then proves to be about 67 per cent. Thus, *in general educational ability, about one-third of the lower age-group surpasses, and over one-third of the higher age-group falls below, the ideal line of division between the two ages.*

In any one age, over 18 per cent. are worse than the average of the age below; and nearly 18 per cent. are better than the average of the age above. This amount of overlapping is about the same as that exhibited in physical characteristics, being slightly less than the age overlap for weight, and, if anything, a little more than that for height. (*See* Appendix II.) As I have already observed, we should expect individual variations to cover a distinctly wider age-range in the case of inborn intelligence than in the case of height or even weight. Hence, *estimates of educational attainments probably minimise the actual amount of age-overlap in higher intellectual capacities.*

Distribution of Age in School Classes.

For school organisation several corollaries seem plain. To avoid overlapping in class-work, different ages must be collected in the same standard. In a school of ordinary size, *a class which is homogeneous in ability must be*

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(1) I have employed a somewhat similar measure of overlap in estimating the mental differences between the sexes. See *Journal of Experimental Pedagogy*, Vol. I., No. 4, p. 283, where the method is discussed at greater length.

TABLE XXVII.-

Overla

Number and Percentage of Children in each age-group surpassing or falli
numbers in Roman figure

Age.	Above Average for			
	Age-group 4 years above.	Age-group 3 years above.	Age-group 2 years above.	Age-group 1 year above.
13 —	—	—	—	—
12 —	—	—	—	Above age 13, 16 *27·6*
11 —	—	—	Above age 13, 14 *21·3*	Above age 12, 24 *36·4*
10 —	—	Above age 13, 8 *12·9*	Above age 12, 21½ *34·7*	Above age 11, 27 *43·6*
9 —	Above age 13, 2 *2·0*	Above age 12, 3 *3·1*	Above age 11, 7 *7·1*	Above age 10, 11 *11·1*
8 —	Above age 12, 0 *0·0*	Above age 11, 0 *0·0*	Above age 10, 0 *0·0*	Above age 9, 9 *10·2*
7 —	Above age 11, 0 *0·0*	Above age 10, 0 *0·0*	Above age 9, 0 *0·0*	Above age 8, 4 *11·1*
Average	0·7 *0·7*	2·8 *4·0*	8·5 *12·6*	15·2 *23·3*

ECHANICAL ARITHMETIC.

Ages.

ow the average for higher and lower age-groups respectively. Actual rcentages italicised.

	Below Average for			
Own age-group.	Own age-group.	Age-group 1 year below.	Age-group 2 years below.	Age-group 3 years below.
Above age 13, 17 *36·1*	Below age 13, 30 *63·9*	Below age 12, 18 *38·3*	Below age 11, 17 *36·1*	Below age 10, 7 *14·7*
Above age 12, 26 *44·8*	Below age 12, 32 *55·2*	Below age 11, 25 *43·1*	Below age 10, 14 *24·2*	Below age 9, 0 *0·0*
Above age 11, 35 *53·0*	Below age 11, 31 *47·0*	Below age 10, 27 *41·0*	Below age 9, 5 *7·6*	Below age 8, 0 *0·0*
Above age 10, 32 *51·6*	Below age 10, 30 *48·4*	Below age 9, 18 *29·1*	Below age 8. 1 *1·6*	Below age 7, 0 *0·0*
Above age 9, 45 *46·0*	Below age 9, 53 *54·0*	Below age 8, 15 *15·2*	Below age 7, 6 *6·1*	—
Above age 8, 35 *40·2*	Below age 8, 52 *59·8*	Below age 7, 31 *35·6*	—	—
Above age 7, 12 *33·3*	Below age 7, 24 *66·7*	—	—	—
28·9 *43·6*	36·0 *56·4*	22·3 *33·7*	8·6 *15·1*	1·7 *3·7*

heterogeneous in age. The standard deviation in such a class will be about 1 year (*cf.* also Table X., column 7); and the range, therefore, about 5 years.[1]

From this standpoint the original table of age and ability (Table IX.) may be fruitfully criticised. As regards age, certain "classes" appear far less heterogeneous, others overlap far less, than we should now expect. An analysis of the apparent anomalies suggests that they are largely due to current modes of departmental and interdepartmental organisation. These doubtless considerably affect the distribution of attainments. But the resulting estimates can hardly represent in every detail the ideal distribution of educational ability. For further study of these problems we clearly need separate returns for ability, for attainments, and for school class. Actual experiments, such as the tests described, should be carried out, not merely in one or two representative schools, but upon an extensive scale.

Meanwhile one inference seems tenable. Methods of promotion should be as flexible as possible. In particular, *the age-limits for promotion, not only from class to class, but, if possible, from department to department, should embrace a range far wider than a single year.*

Overlapping of Classes.

We may now enquire what is the amount of overlap in single subjects between the various classes. How far is it reduced in actual practice by classifying the children in standards according to General Educational Ability, instead of leaving them in simple age-groups?

Figure 12 shows the distribution of ability in Mechanical Arithmetic among the children of the different classes. It will be seen that the amount of overlap of the different classes and the amount of heterogeneity within the same class is unexpectedly large. Standard IV. contains children corresponding to the averages of seven different classes, namely, from standards I. to Va. The six higher classes also cover a range almost as large, namely, the seven classes from standards IV. to VIIa. In standard VIIa. one child is working 260 figures correctly while another can only work 60. The former works over four times as rapidly and correctly as the other.

On amalgamating the distributions as before, the amount of overlap is 78·4 per cent. Twenty-nine per cent. of the children in any class are better than the average of the class above, or worse than the average of the class below. *In a mechanical subject, therefore, such as Arithmetic (Rules), and especially in the higher parts of the school, the classes may overlap quite as much as the age-groups.* Indeed, an overlap diagram for the classes would differ almost inappreciably from that for age-groups. It should be remembered, however, that whereas there were only seven age-groups, there are as many as eleven classes. It might be imagined that to increase the number of groups would render the groups themselves more homogeneous internally. This, however, has not been effected. Indeed, with a unilinear or serial scheme of school organisation it seems difficult to sort half-a-dozen large age-groups into more than half-a-dozen small school-classes and at the same time secure homogeneity. This is perhaps an argument for some parallel scheme of school organisation—some plan of promotion, whereby the quick-learners should not be mingled in the same class and not be expected to follow the same line of progress as the slow learners.

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(1) Within the limits of ± 2·5 S.D., *i.e.*, within a total range of 5 S.D., fall nearly 99 per cent. of a normally distributed group.

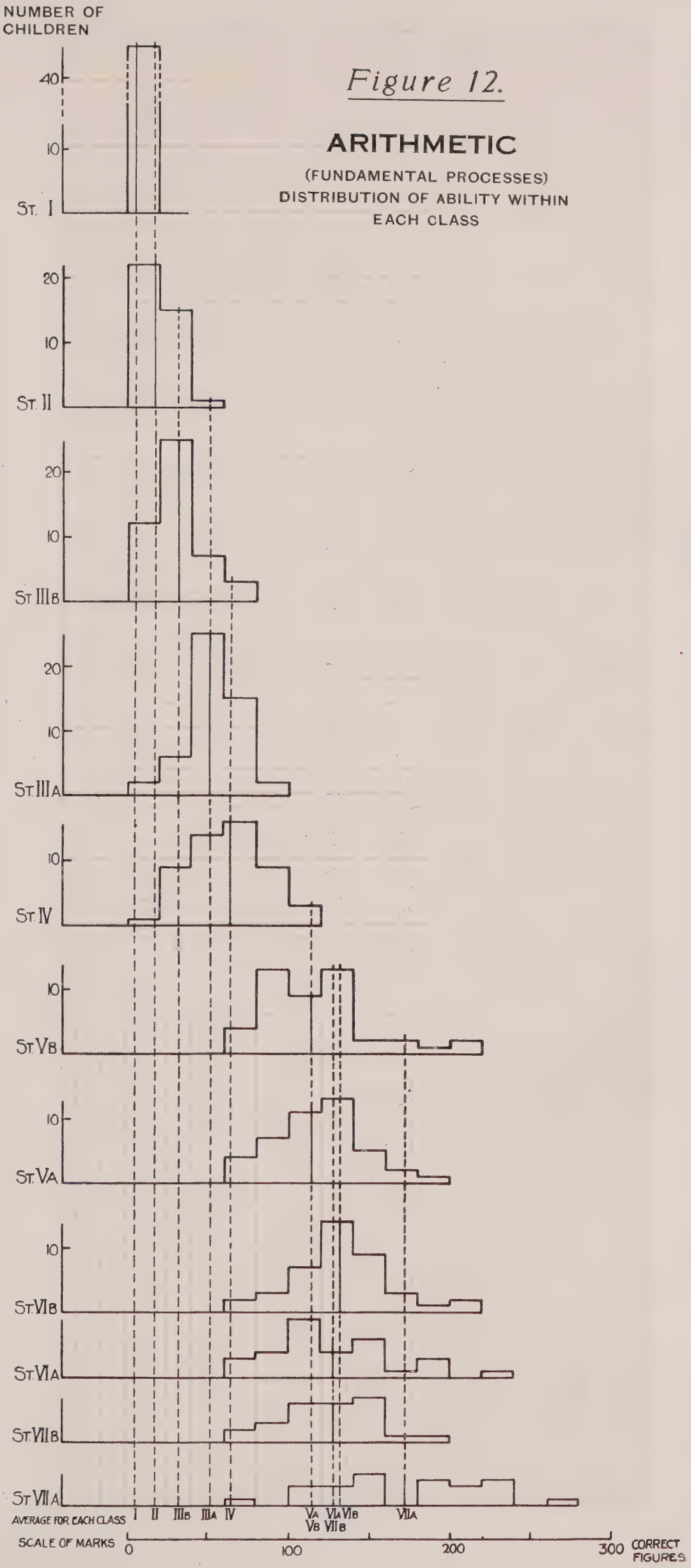


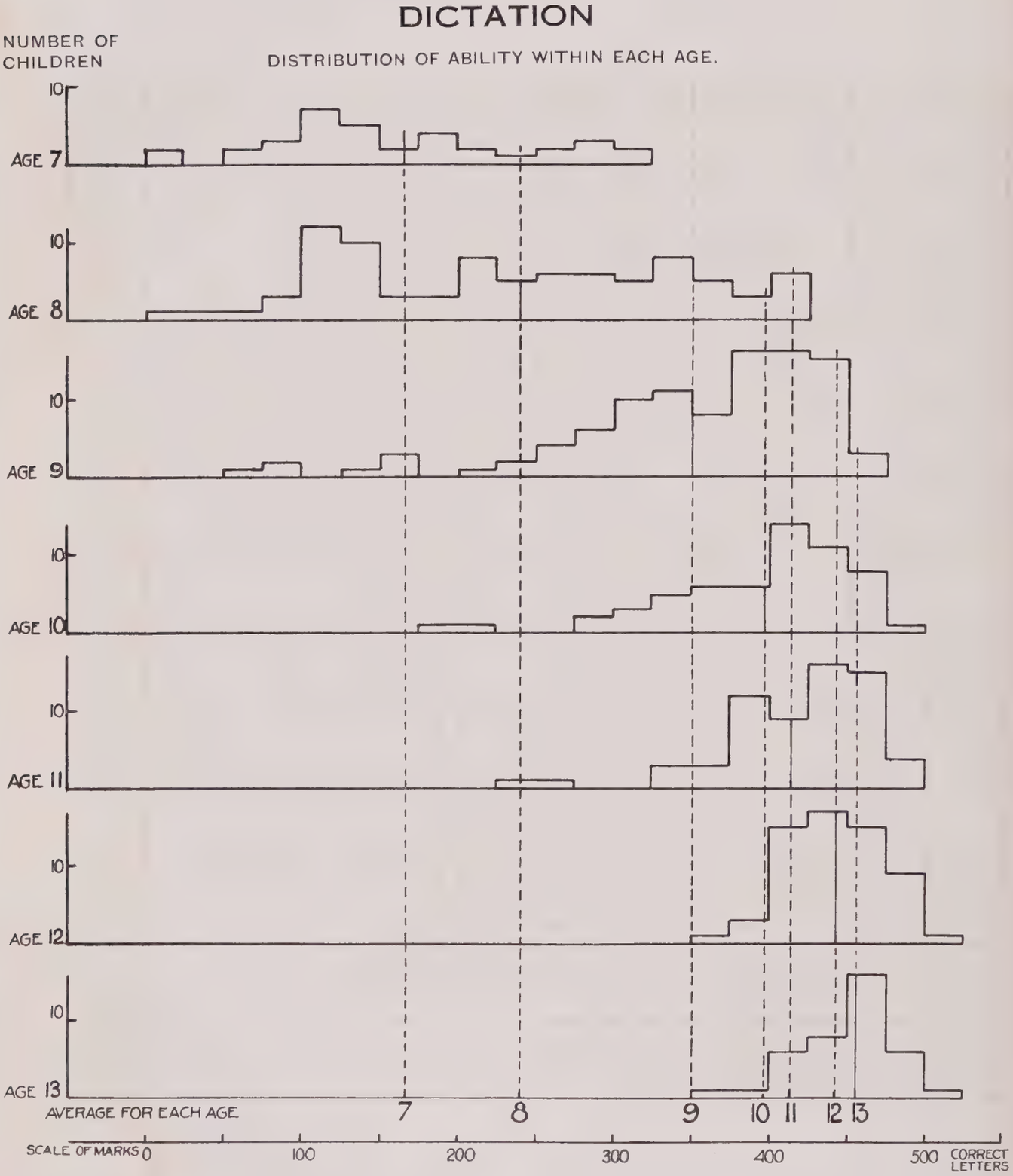
Figure 12.

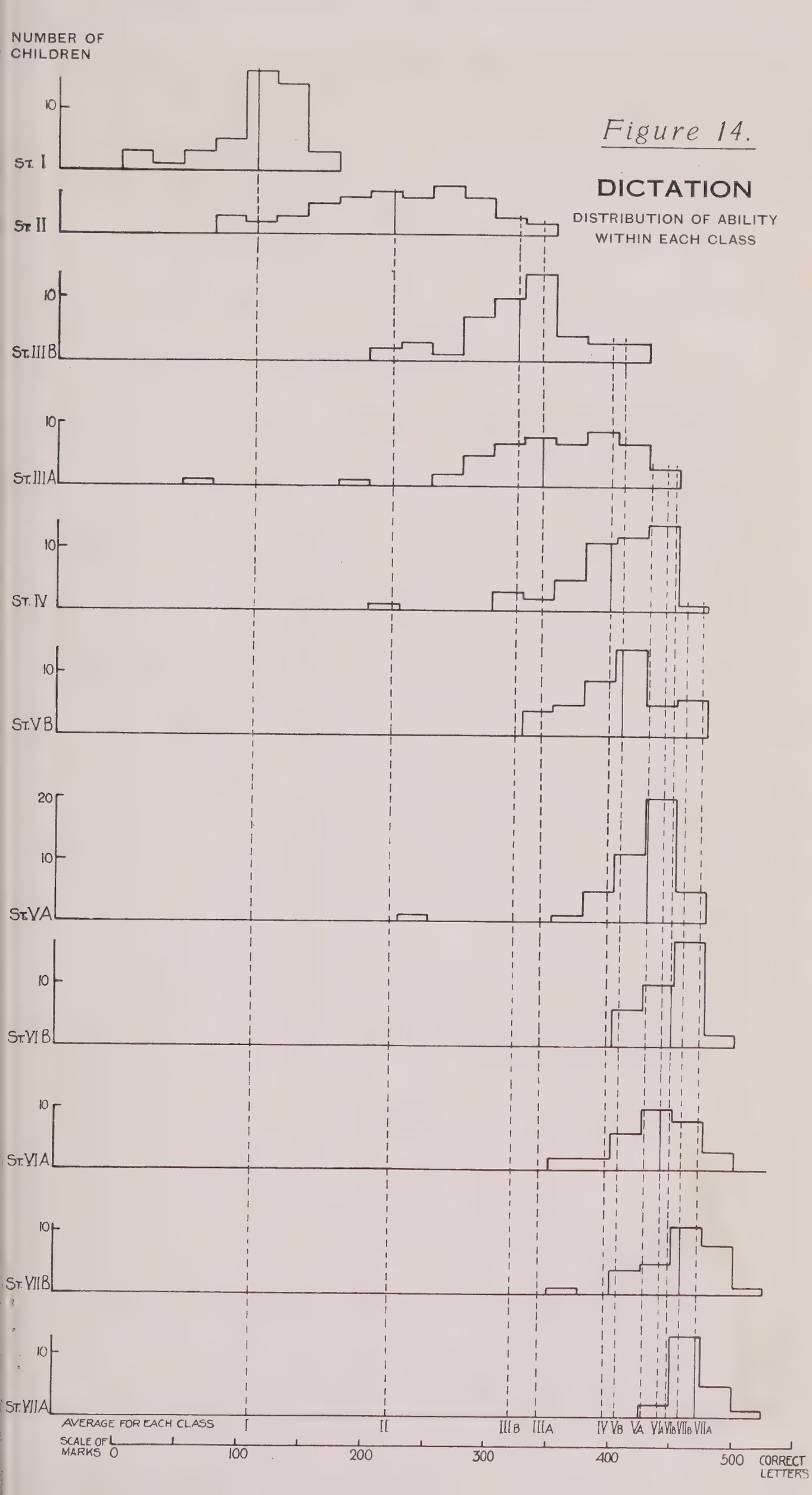
ARITHMETIC

(FUNDAMENTAL PROCESSES)
DISTRIBUTION OF ABILITY WITHIN EACH CLASS

(Between pp. 72 and 73.)

Figure 13.


DICTATION
NUMBER OF CHILDREN
DISTRIBUTION OF ABILITY WITHIN EACH AGE.
10
AGE 7
10
AGE 8
10
AGE 9
10
AGE 10
10
AGE 11
10
AGE 12
10
AGE 13
AVERAGE FOR EACH AGE
7
8
9
10
11
12
13
SCALE OF MARKS
0
100
200
300
400
500
CORRECT LETTERS


NUMBER OF CHILDREN
Figure 14.
DICTATION
DISTRIBUTION OF ABILITY WITHIN EACH CLASS
St. I
St. II
St. III B
St. III A
St. IV
St. V B
St. V A
St. VI B
St. VI A
St. VII B
St. VII A
10
20
AVERAGE FOR EACH CLASS
I
II
III B
III A
IV
V B
V A
VI A
VI B
VII B
VII A
SCALE OF MARKS 0
100
200
300
400
500
CORRECT LETTERS

The most obvious reform, however, would be (so far as administrative considerations permit) to re-classify for different subjects or groups of subjects. The children have already been classified on the basis of general scholastic attainment; yet in one particular kind of attainment, Mechanical Arithmetic, no approach to homogeneity has been made. As far as this subject is concerned, the children might almost as well have been left in their original age-groups. This result, however, does not by any means reflect upon the skill with which the classes have been formed. It is an inevitable consequence of the low correlation of ability in mechanical arithmetic with General Educational Ability as a whole. To classify for the one is obviously not to classify for the other.

Re-classification for Special Groups of Subjects.

For what subjects, then, must we re-classify? Is Arithmetic the only subject calling for such re-classification? Or have we to re-classify for each and every subject that we can teach or test?

Arithmetic is by no means the only subject for which re-classification is needed. If we examine the results for Dictation we shall find the same heterogeneity and overlap appearing, though it is less marked in the lower ages and classes (Figures 13 and 14). Among the age-groups the average amount of overlap appears to be much the same in Dictation as for Mechanical Arithmetic, namely, 77·6 per cent. Among the classes, however, the overlap is somewhat less, namely, 75·0 per cent. This slight reduction in overlap we might expect; for Dictation is more highly correlated with General Educational Ability than Arithmetic, and appears to be less dependent upon specialised capacity.

Similar results are obtained upon examining the distribution for Reading and for Drawing and Handwork. In the former the overlap is nearly as great as in Arithmetic and Dictation; in the latter distinctly greater.

On turning, however, to subjects like Composition and Arithmetic (Problems), the overlap between the different classes is reduced very considerably; while the overlap for the age-groups is reduced but little. The estimates of overlap differ greatly from school to school. Much, too, depends upon the way in which the arithmetical problems are set and the compositions marked. If the subject-matter be too closely related to the special work of the several classes, the overlap may be considerably minimised. Indeed, it is probably the custom of examining each class purely upon its own syllabus that has hitherto concealed the overlap in ability which actually exists. As a rule, however, the overlap in these subjects varies between 15 and 25 per cent. The small figure is due chiefly to the fact that in the higher standards the children are very largely classified according to attainments in these subjects.

Overlapping, then, is clearly greatest in those subjects which depend least upon General Educational Ability and most upon some special ability. But, as we have seen, some of these subjects are highly correlated among themselves, and form groups dependent upon much the same special ability. Thus, if the children are re-classified for Dictation, the re-classification may serve also for Reading; similarly, a reclassification for Arithmetic (Rules) may serve very largely for Arithmetic (Problems). But neither Dictation, Arithmetic, nor General Educational Ability will yield

homogeneous classes in Drawing or Handwork. The subjects, therefore, for which re-classification seems desirable are those which show high positive specific correlation with one another. These, as we have seen, fall into three or four main groups. *If, then, the main classification is based largely upon work in the Composition group, re-classification may be desirable for Manual, perhaps for the Linguistic, but, above all, for the Arithmetical subjects.*

These recommendations are, of course, made with certain reservations. Psychological considerations alone are under review. Wholesale re-classification in every school or at every age, regardless of other considerations is not, for a moment, suggested. For certain subjects, homogeneity is neither necessary nor desirable. And, further, a class which is homogeneous in attainment at the beginning of the school year, may become very heterogeneous by the end of six months, unless its members are equal in ability to learn as well as in actual attainment. But, for all the subjects where collective teaching is necessary, it clearly makes for efficiency if the children to be taught together are, as nearly as possible, upon the same level in initial attainments, in quickness of comprehension, and in power to retain. Much can be done without the actual formation of fresh classes. The children in a given class may in turn be subdivided for special subjects into sections or sets. The greatest overlap occurs, as we have seen, in the higher classes, when examined in the more mechanical subjects, like Arithmetic (Rules); in the lower classes the mechanical subjects show high correlation with general ability, and, indeed, very largely form the criterion by which the children are classified and promoted. Now, in the higher classes, the children are, by hypothesis, more intelligent. And upon intelligence the acquisition of knowledge, even in mechanical subjects, very largely depends. Indeed, work in these subjects only becomes mechanical when it has been thoroughly learnt. Hence, brighter children who exhibit special defects in the fundamental subjects, need, as a rule, only a little additional coaching, with special adaptation of methods to their individual difficulties, to enable them to reach or nearly reach the normal level. This may require, for the special subject, relegation, not to a special class, but only to a special section within the ordinary class. What is important, however, is that *a normal or an able child should not be kept back in a low class for all subjects, simply because he is deficient in one special branch—perhaps a "mechanical" branch—of school work.* Whether this is to be avoided by re-classification in classes or in sections will depend upon other considerations.

Overlap of Classes in General Educational Ability.

To obtain a measure of General Educational Ability, the marks for each school subject, first weighted according to its correlation with the "hypothetical general factor," must again be averaged. The overlap of classes is then distinctly smaller than for the subjects taken severally. In well-organised schools the figure varies between 0 and 15 per cent. But for so complex a capacity, as indeed for the more complex special capacities, the figures for overlapping are but little more than rough approximations. Further, the estimates differ considerably from school to school. In a few schools undoubtedly, the overlapping is marked, and much could still be done by a more systematic analysis of children's attainments to produce classes more completely homogeneous. The estimates, too, vary considerably with slight

differences in the method of marking and weighting the marks. Into the technicalities of these methods it is scarcely desirable to enter. And I therefore give no detailed tables and figures for these latter capacities.

In the present discussion an important consequence of the overlap of classes in General Educational Ability lies in its bearing upon the age-and-standard survey in the foregoing memorandum. In the case of the ordinary schools, it was impracticable to test every child, as was done in the special schools. Estimates were, therefore, used, based primarily upon the school classes. The measures of overlap enable us to judge the error involved in such a survey. Clearly, the error exists; but cannot be very large. Upon enquiry, *the chief source of overlap appears to be the express promotion of older, backward children on the ground of age, regardless of ability, and the retention of younger advanced children in classes somewhat low for their ability.* The latter is not carried out consciously and expressly so often as the former; but it appears upon investigation almost as frequently. As far as possible, these cases were allowed for, before drawing up the tables of distribution. The rest must tend to some extent to neutralise each other. The main effect, where they remain, will be to reduce somewhat the frequency of the more extreme deviations. Hence, our study of overlap suggests that *the estimates of backwardness, if anything, somewhat understated the total amount.* The slight error could only be avoided by organising a complete survey of the schools by means of a uniform scheme of examination.

Practical Methods of Analysis and Record-Keeping.

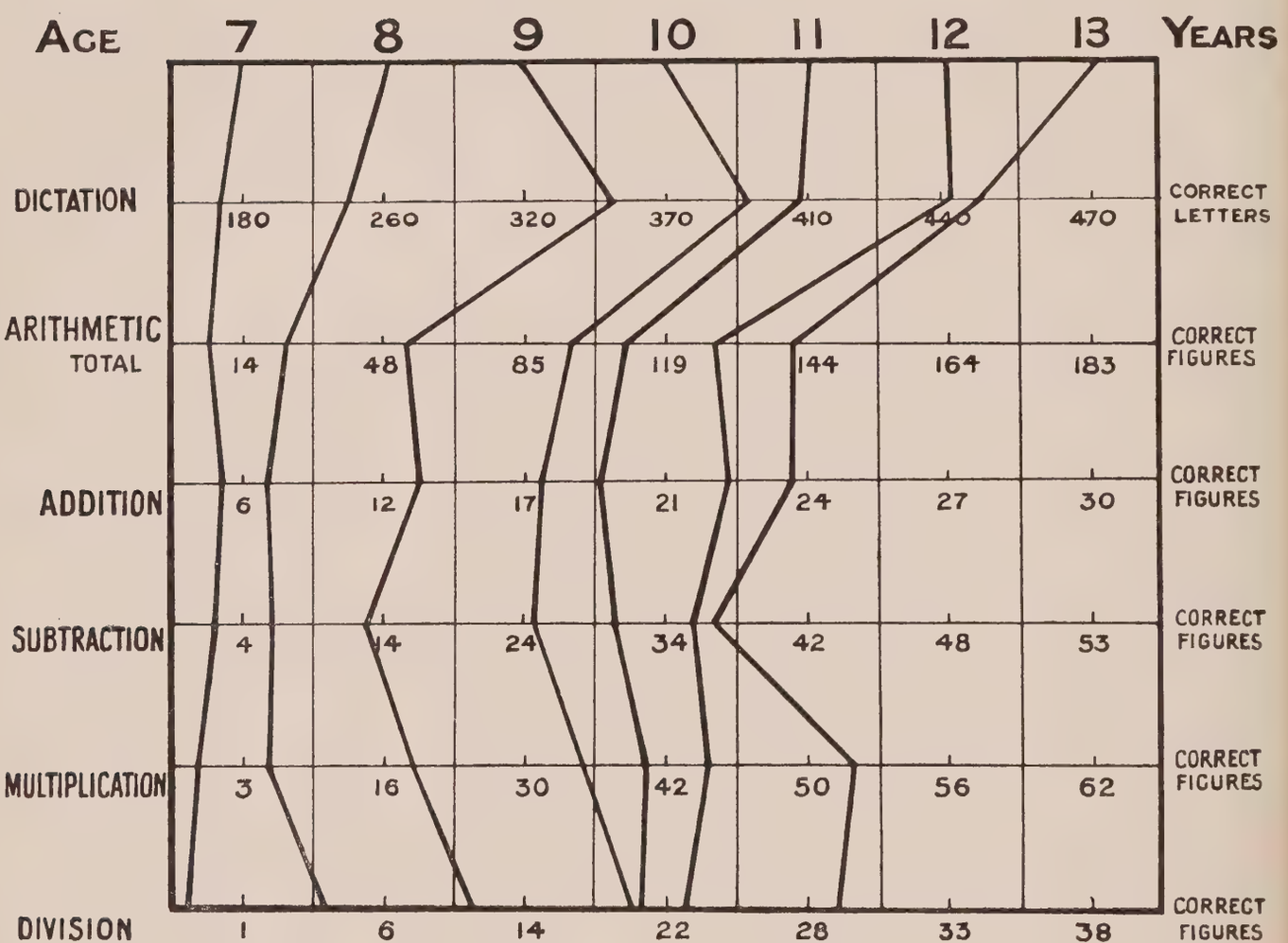
Schemes of distribution, such as those in Figures 11, 12, 13 and 14, are extremely simple to draw up. They yield a clear picture of conditions of the school. Besides overlap of classes, other features are quite plainly brought to light by the figures here given; for instance, the gap made in the upper half of the higher classes by the results of the junior scholarship examination; the able children still left behind, whom, for one reason or another, the scholarship system has not selected; the division of the school into halves, at the line separating standards IV. and Vb., largely on the basis of ability in Mechanical Arithmetic.

There are many other simple devices which may be employed in conducting a sort of periodical stock-taking of the attainments of the various sections of the school. I have already described how clearly a psychograph will exhibit the special deficiencies and aptitudes of an individual in particular subjects; it yields perhaps the most convenient basis for card-indexing him. Similar graphs may be devised for age-groups and classes. Figure 15 illustrates a method for plotting the attainments of the different ages in the different subjects. The graphs show the actual attainments, revealed by tests at a particular school, compared with the normal attainments (or " norms ") for the several years. The early progress, especially in Dictation, the subsequent falling off, especially in Arithmetic, are both clearly revealed. As norms for the less mechanical subjects are at present difficult to compile, only attainments in Dictation and Arithmetic (Rules) are given. Any head teacher, however, could easily work out for all subjects his own set of norms, by means of which he could keep tables of the progress of different classes and ages.

FIGURE 15.

DICTATION AND ARITHMETIC.

Averages for the several Age-groups in a particular school compared with the corresponding 'Norms'.



As a final, and, in some ways, most suggestive method of practical analysis of school proficiency, I give tables of the averages for age-groups within each class at the school from which most of my illustrations have been taken. Hitherto, I have given curves and tables for age-groups and classes separately. These reveal the fact of overlap. But, for practical purposes, a study of the attainments of the different age-groups within the different classes is still more valuable; for this should reveal the defects of organisation which are the cause of overlap. The averages are given for Mechanical Arithmetic in Table XXVIII. and for Dictation in Table XXIX. Marks for Addition, Subtraction, Multiplication, and Division are given separately in Table XXVIII. to illustrate the value of a close comparison of marks for different tests.

It will be seen that the oldest children in nearly every class are the weakest; and the youngest, with but very few exceptions, are the best. In standard Vb., however, the oldest children surpass (except, perhaps, in subtraction) the general averages in Arithmetic for the three classes above them, and almost reach those averages for the two standards VII. It seems, therefore, unfortunate to keep older children in a low standard when they are able to do some of the work of a higher standard even better than younger children already promoted. The reason for so doing is clear.

XXVIII.—MECHANICAL ARITHMETIC.

Average for each Age-group in each Class.

The averages for each age and each class are obtained by weighting the Figures for the age-groups in each class according to the number of individuals comprising them.

Age.	Test.	Standard.											Average for each Age.
		VIIA.	VIIB.	VIA.	VIB.	VA.	VB.	IV.	IIIA.	IIIB.	II.	I.	
14 —	Addition ...	41·0	...	...	...	...	...	...	...	...	...	...	41·0
	Subtraction	38·0	...	...	...	...	...	...	...	...	...	...	38·0
	Multiplication	71·0	...	...	...	...	...	...	...	...	...	...	71·0
	Division ...	42·0	...	...	...	...	...	...	...	...	...	...	42·0
13 —	Addition ...	27·4	21·0	17·2	22·0	...	...	...	...	...	...	...	23·8
	Subtraction	40·0	31·0	41·0	41·5	...	...	...	...	...	...	...	37·6
	Multiplication	62·1	46·0	36·5	44·3	...	...	...	...	...	...	...	52·1
	Division ...	39·6	20·5	20·5	15·5	...	...	...	...	...	...	...	28·8
12 —	Addition ...	29·0	21·2	22·0	22·0	16·0	28·0	...	...	...	..	...	22·0
	Subtraction	46·5	31·4	39·5	38·2	24·7	37·8	...	...	...	...	...	36·2
	Multiplication	77·0	55·8	40·3	43·4	29·3	48·4	...	...	...	...	...	44·8
	Division ...	52·5	23·1	20·8	19·2	18·0	34·6	...	...	...	...	...	23·0
11 —	Addition ...	...	...	23·6	24·2	18·0	17·2	10·7	24·0	...	...	...	19·1
	Subtraction	...	...	43·8	40·8	34·3	24·2	10·6	18·0	...	...	...	31·4
	Multiplication	...	...	57·8	47·8	40·4	38·3	18·7	8·0	...	...	...	40·4
	Division ...	...	...	28·6	21·6	21·5	22·4	10·3	9·0	...	...	...	20·9
10 —	Addition ...	...	...	...	25·2	19·1	22·2	12·3	14·4	7·0	...	...	17·9
	Subtraction	...	...	...	46·4	36·5	28·9	10·7	9·1	11·0	...	...	24·2
	Multiplication	...	...	...	55·4	44·3	45·1	23·4	15·9	6·0	...	...	35·7
	Division ...	...	...	...	30·0	27·0	26·6	9·5	9·1	5·0	...	...	19·8
9 —	Addition ...	...	...	...	...	20·4	20·2	14·0	13·8	9·8	3·8	...	13·1
	Subtraction	...	...	...	...	41·6	33·5	11·4	10·6	8·5	1·4	...	12·9
	Multiplication	...	...	...	...	45·2	33·3	28·3	17·7	9·8	2·4	...	20·0
	Division ...	...	...	...	...	26·0	20·5	13·2	12·4	3·3	0·2	...	11·0
8 —	Addition ...	...	...	...	...	...	...	14·0	13·9	9·0	4·7	2·6	6·6
	Subtraction	...	..	...	...	...	...	17·2	10·2	9·8	7·2	0·0	6·7
	Multiplication	...	...	...	...	...	...	31·2	18·2	8·9	4·0	0·0	6·8
	Division ...	...	...	...	...	...	...	14·5	9·0	3·3	0·5	0·0	2·6
7 —	Addition ...	...	...	...	...	...	...	...	...	7·0	4·4	2·2	3·3
	Subtraction	...	...	...	...	...	...	...	...	5·0	5·8	0·0	2·8
	Multiplication	...	...	...	...	...	...	...	...	11·0	2·5	0·0	1·4
	Division ...	...	...	...	...	...	...	...	...	1·0	0·25	0·0	0·1
Average for each Class.	Addition ...	27·6	21·1	20·9	23·4	18·3	20·8	13·0	14·1	9·3	4·4	2·9	15·1
	Subtraction	40·7	31·2	40·4	40·8	34·4	28·8	11·5	10·5	9·1	6·0	0·0	20·4
	Multiplication	62·7	50·3	42·7	46·9	40·5	41·8	25·6	17·3	9·3	3·2	0·0	27·6
	Division ...	40·8	21·7	22·1	21·0	23·1	25·2	11·7	11·3	3·3	0·4	0·0	14·5

TABLE XXIX.—DICTATION.

Averages for each Age-group in each Class.

The averages for each age and each class are obtained by weighting the figures for the age-groups in each class according to the number of individuals comprising them.

Age.	Standard.											Average for each age.
	VIIA.	VIIB.	VIA.	VIB.	VA.	VB.	IV.	IIIA.	IIIB.	II.	I.	
13 —	466·4	437·5	403·2	420·3	...	...	...	...	...	...	...	445·7
12 —	481·4	477·0	440·1	435·6	408·8	403·2	...	...	...	...	...	443·4
11 —	...	...	465·8	453·6	420·4	389·8	324·5	338·0	...	...	...	411·9
10 —	...	...	...	456·8	438·2	409·6	386·9	280·6	...	...	...	397·4
9 —	...	...	...	...	437·0	403·8	414·6	352·1	307·6	127·8	165·0	350·0
8 —	...	...	...	...	...	...	408·5	384·0	329·4	231·5	110·3	237·3
7 —	...	...	...	...	...	...	...	...	378·0	224·2	102·3	167·0
Average for each class.	468·0	456·3	440·3	445·2	425·1	401·0	395·0	345·2	319·1	218·9	108·0	348·8

This group is somewhat weaker than the standard above in Dictation, and also (though I do not give the tables) in subjects depending very largely upon the same ability, such as Composition. Once the proficiency of these children in Arithmetic was pointed out, the teacher readily agreed that it more than compensated for the disability in spelling. But, without some simple method of analysis, such proficiency was quite naturally overlooked. Once more, in standard VIB. the thirteen-year-old children surpass the children of the same age in the class above them in Dictation and in Arithmetic (Rules) except Division. In some tests they surpass those two or three classes above them. They are somewhat behind in Arithmetic (Problems), but not much behind in Composition and allied subjects. Once more, therefore, with a little special coaching in the more difficult Arithmetical work they might well be promoted to a class more suited to their age.

I cite these cases merely to illustrate the practical problems which are at once revealed by an analysis of the organisation of a single school. Such tabulations will reveal, with very little trouble, what groups in a given department are particularly weak, what groups are ready for promotion, and in what subjects they are respectively weak and strong. To do so, of course, has not been part of my aim. But as an incidental consequence of the tests, many such cases have come to light, often unsuspected by the teachers concerned, and the recommendations thus indicated have been acted upon and have met with success. Once the method has been devised and understood, the analysis itself requires but little labour. It could readily be done by the intelligent pupils of an upper standard for the whole school.

Theoretical Schemes of School Organisation.

The foregoing figures suggest that, in particular schools at least, methods of classification and promotion might be improved. On the basis of statistical surveys and experimental tests, such as those above described, it would be possible gradually to work out the most probable distribution of ability in each subject among children at every age. The data at present available are sufficient only for the roughest approximations. As a sample I give in an appendix a calculated scheme of the most probable number of children showing different degrees of achievement in general educational ability as a whole (Table XXXII., pp. 90-91).

The Need for Research.

None of the conclusions in these memoranda are presented as anything but preliminary and tentative. At the best they can provide but working hypotheses, awaiting further verification or amendment. The methods are perhaps more suggestive than the results. But even the methods need special study, to render the procedure more simple and the modes of calculation more exact.

There is, therefore, in education a vast field for practical research. Unlike other professions, such as medicine or engineering, teaching still relies largely for guidance upon private experience, personal impression, and professional tradition. These resources are supplemented by unsparing devotion, unfailing sympathy, hard work, and common sense. But they are not enough. Admirable as they are, yet of necessity they leave the practice of education at the present day where the practice of medicine was a century ago. They leave it without any scientific foundation. The engineer is regarded as an expert; the physician as a man of science. But those whose business is to care for the mind and build up character are subject to daily criticism, by the public or in the press, as though they were themselves amateurs. And the distinction is a just one. For years to come, where mind and character are to be dealt with, there can be none but amateurs. Knowledge here is in its infancy, and science but a few years old. The real need, therefore, is for research. Only through research can scientific knowledge take the place of unverified opinion; and only through scientific knowledge can practical efficiency be attained.

Such investigations must for the most part be left to a small band of trained volunteers. But methods of enquiry are now available—technical and cumbrous enough, it is true; and problems and hypotheses can be formulated which involve issue of administrative interest. These then are the two points which it has been the chief aim of these memoranda to demonstrate: the feasibility of educational research and the practical value of the probable results.

When the present crisis is over, the nation will stand confronted with the task of social reconstruction. In preparation for this national overhauling one urgent item is the research for which I have appealed. To take the place of the ability that has been lost to the community, we have to discover the best methods of detecting fresh supplies of ability and the best means of training and utilising it to the utmost of which it is capable. Scientific research in education is thus needed not only to enhance the practice and profession of teaching, but also in the near future to promote the welfare of the nation.

SUMMARY.

An educational survey has been made of a single representative borough, by means of teachers' estimates, checked by experimental tests.

The general educational abilities of all the children in all ordinary elementary and special (M.D.) schools have been assessed either individually or in groups. The final estimates have been expressed in terms of grades and standards, treated as a continuous, fractionable scale.

I.—DISTRIBUTION OF EDUCATIONAL ABILITY IN *SPECIAL (M.D.) SCHOOLS.*

All the special (M.D.) school children have been tested individually or in class. The results for each school have been tabulated to show the number of children at each age assigned to each grade. (See, especially, Table II.)

The educational distribution of the entire special (M.D.) school population is shown in Figure 1.

The various methods of measuring deficiency are exemplified in Figure 2, which indicates the following conclusions (see also Table IV.):—

1. The educational development of "defectives" is about twice as slow as that of "normals," viz., about half a "class" per annum. Their average level is that of a lower grade iii. (normal age, $6\frac{1}{4}$). Few are in, none above, standard II. (Figure 2, A.)
2. They increase in backwardness from 3 years at seven to 8 years at sixteen. On an average, they are retarded educationally by about five years. (Figure 2, B.)
3. They deviate from the average level of ordinary children by four to five times the "standard" deviation of "normals." (Figure 2, C.) In educational ability, they deviate invariably *below* the normal average, whereas normal individuals, of course, deviate on either side of their own average.
4. They possess on an average 54 per cent. of the educational attainments of "normals" of the same age. (Figure 2, D.)

In short, *the educational attainments of a "defective" correspond, on an average, to those of a "normal" just over half his age.*

Of the various methods of estimating deficiency, the ratio of attainments to age seems preferable to the commoner statements of "mental age" or "retardation," since the former alone is approximately the same at all ages. The "standard" deviation of normals of the same age, though somewhat cumbrous, forms perhaps the best unit of all.

Measured by these methods, the differences observed at different schools prove suggestive, but too small to be reliable without confirmation by the experimental tests.

Special school children are distinguished from those in ordinary elementary schools by educational deficiency far more than by deficiency

in general intelligence. They are perhaps to be regarded primarily as school failures, and not always therefore as "mental defectives" in the narrower sense.

The assignment of an upper limit, dividing special school cases from "normals," requires a survey of the population of the ordinary elementary schools.

II.—DISTRIBUTION OF EDUCATIONAL ABILITY IN *ORDINARY ELEMENTARY SCHOOLS.*

All the children in the ordinary elementary schools of the borough have been reviewed in a survey analogous to that of the special schools.

The "extensive" portion of the survey is based upon the distribution of the children by age and class. The "intensive" portion of the survey consists of experimental studies of sample schools and individuals selected as controls.

The final results have been tabulated as an age-and-ability schedule for the whole borough. Frequency-diagrams showing the distribution of ability at each age are given in Figure 3.

Only in the middle age-groups do the children examined constitute a fair, unbiassed sample. For these ages the form of distribution approximates to the "normal curve of error," *i.e.*, different degrees of ability apparently occur with definite frequencies, simple and predictable in the long run, and closely resembling those ascribed to "chance."

The correlation between age and class is high but imperfect. Roughly,

Age = Standard + 6.
Standard = Age − 6.

More exact equations are formulated on p. 24.

Estimates of the degree and frequency of backwardness involve two criteria: (1) a "norm," or level chosen as characterising the normal child, for each age; (2) a unit to measure deviations from the "norm."

A.—Preliminary Analysis.

The normal child may be expected to attain a new class or standard in each successive year. On reaching the age of 13, he should enter standard VII. Each year that he misses will count as one year's retardation.

The frequency of the various degrees of backwardness and advancement, as thus estimated, is shown in Table XI. and Figure 4.

Judged by these standards, nearly 700 ordinary children appear backward by 3 years or more: *nearly* 3,000 *appear backward by* 2 *years or more.*

The amount of backwardness in the Non-provided schools considerably exceeds that in the Council schools.

The total distribution is not normal, but asymmetrical and peaked. Those "above age" are only half as numerous as those "below age"; and there is a central peak of younger children assigned without differentiation to the central group ("level with their age").

These peculiarities are due to the choice (*a*) of norms and (*b*) of units:—

(*a*) The "one-year, one-class" criterion seems to place the normal level too high. In their last school year children reach on an

average, not the middle of standard VII., but a point near the top of standard VI. Hence, for a just standard of normality at each age, the prevalent or "modal" class, treated hitherto as an indivisible unit, must be replaced by the exact mean level, expressed if necessary in fractions of a class. (Table X.)

(*b*) Measured simply in terms of years, the apparent amount of backwardness and variability increases from year to year. The best measure of variation is provided by the average (or "standard") deviation. For the middle age-groups it is, approximately, one "educational year." With increasing age it increases in direct proportion. Approximately, it may be taken as equal to one-tenth of the age.

Backwardness, therefore, will best be expressed as a variation that is so many times the average ("standard") deviation below the exact mean found for every age.

B.—Re-Analysis.

With norm and unit thus readjusted, both "ordinary" and "defective" children have been reclassified. The comparative distribution of the two groups is shown diagrammatically in Figure 6.

The form of the total distribution for "ordinary" children now approximates more closely to the "normal curve of error."

The overlap between "normals" and "defectives" is not so great in educational ability as in general intelligence. The line between ordinary and special school children appears to be drawn at about −3 S.D. (*i.e.*, a retardation of about 30 per cent. of age). Defectives are found, however, as high up the scale as −2 and −1 S.D.

The number of children below the level proper to their age is now considerably reduced. Only 1,441 are backward by −2 S.D. or more, *i.e.*, by two or more tenths of their age.

This estimate is undoubtedly too low. Allowance has to be made for backward children assigned to a class above their attainments, and for other disturbances in the data. A stricter definition of backwardness is also needed.

For practical purposes, "backward" may be taken to denote children, who, though not "defective," are yet unable, in the middle of their school career, to do the work even of the class below their age; or, more exactly, children who deviate below the normal by at least one and a half times the "standard" deviation of individuals of the same age-group; and, therefore, are retarded by 15 to 30 per cent. of their age.

In this sense, and with the above allowances, *the total number of "backward" children in the senior departments of the borough may be assessed at about* 2,000,—10 *per cent. at the very lowest estimate.*

Tentative suggestions are made as to the causes of backwardness, and as to measures for its relief.

A rough estimate has been made for the distribution of educational ability among the elementary school population of all London. It is shown diagrammatically in Figure 7. *In the whole county, the number of backward children between eight and fourteen is estimated as being at least from thirty to fifty thousand.* The figure necessarily varies according to the line of demarcation adopted, especially in the case of older children.

Completely to fill the accommodation provided by all special schools with children selected purely on grounds of educational deficiency, the lowest 1·51 per cent. would have to be cut off from the joint normal and defective school

population. *This indicates, as the highest possible limit for candidates for the statutory examination, a retardation of at least one quarter of the age.* The limit for each age is given in Table XVI. in terms of grades and standards. *For actual admission, the line of demarcation will probably be drawn at a retardation of about 30 per cent. of age.* But for all cases retarded by less than 50 per cent. of their age, evidence of non-educational deficiency should be required. Otherwise, the cases might well be recommended for a backward class or school.

III.—RELATIONS BETWEEN GENERAL AND SPECIAL EDUCATIONAL CAPACITY.

Experimental tests of the chief subjects of the school curriculum have been applied in typical schools. It is hoped eventually to draw up a standard set of tests for both educational and psychological capacities and to determine the relationships between them.

Many capacities can be measured only in terms of an arbitrary scale. A tentative scheme of marking has been drawn up for this purpose, based upon the assumption that mental capacities follow approximately a " normal " form of distribution.

The relationships between abilities in all the school subjects tested have been studied among both normal and defective children by the method of correlation. *Scholastic achievements appear to be determined by mental factors of two kinds:—*

(1) *General Educational Ability,*—a hypothetical common factor entering into all school work. This is a complex capacity. Partly it is dependent upon a still more general factor, namely, " general intelligence " (all-round mental efficiency). To a certain extent it involves moral as well as intellectual capacities. It determines performances in different school subjects in different degrees; such subjects as Composition, and perhaps problem work in Arithmetic, are intimately dependent upon it, and, suitably tested and marked, perhaps form the best tests.

Among children of special (M.D.) schools, the evidence for a general factor underlying educational abilities and disabilities of every kind is not so clear. In administrative practice, " mental deficiency " implies among different children deficiencies in very different capacities, both general and specific.

(2) *Specific Educational Abilities,*—special aptitudes confined to special subjects and groups of subjects. These, apparently, depend partly upon psychological factors, largely innate, *e.g.*, ability to visualise or work with visual schemes; ability to form associations of definite kinds,—verbal, numerical, spatial, logical; facility in forming hand-and-eye co-ordination. Partly they are moral rather than intellectual, determined by interest in the subject and the personality of the teacher. The culture of the home, too, appears to have a marked influence upon certain subjects, *e.g.*, Composition..

When the influence of General Ability is allowed for, *the school subjects tested fall into four main groups, apparently dependent upon four specific abilities,* complex, and nearly, though not entirely, independent:—

i. Arithmetical.
ii. Manual.
iii. Linguistic.
iv. Literary.

As compared with the differences between successive ages, differences between individuals of the same age exhibit much the same range in educational ability as in height, a range somewhat less than in weight, and distinctly less than in intelligence.

Consecutive age-groups overlap enormously. The overlap is greatest in the single subjects taken severally, and especially in those dependent upon inborn aptitude more than upon acquired knowledge. Even in general educational ability one-third of a given age-group will fall below the point midway between the averages for that age and the age below; and one-third will fall above the point midway between the averages for that age and the age above. Hence, *to be homogeneous in educational ability a school class must be heterogeneous in age.* It should embrace a range of about 5 years. This in turn demands a more flexible scheme of promotion from class to class, and, above all, a wider range of age in promoting from infants' or junior mixed departments to those above.

In an appendix a model scheme of classification by age and standard is worked out. This shows the theoretical distribution of children according to ability at each age on the hypothesis that the distribution follows the "normal curve."

In a well-organised school the various classes should be, and are, fairly homogeneous as regards general educational ability. Adjacent classes overlap but little. But, however homogeneous as regards general educational ability, in subjects not closely correlated with general educational ability, they are bound to be heterogeneous and to overlap considerably. The subjects in which heterogeneity and overlap appears most are the more mechanical subjects, which, in the higher classes, are but little dependent upon general ability, and, in particular, those subjects which are dependent most upon specific capacity. For these subjects it is often desirable to cross-classify either school or classes.

In order to analyse and record the general and special capacities of individuals, classes and schools, and to study the heterogeneity or overlapping of age-groups and classes, simple statistical and graphic devices are essential. Methods of tabulating and plotting test-results, used with advantage in the present experiments, are, accordingly, given in illustration. It is hoped that they may prove serviceable to teachers and others in the practical work of surveying the schools under their supervision.

CYRIL BURT.

15th February, 1917.

APPENDIX I.

DISTRIBUTION OF PHYSICAL CHARACTERISTICS AMONG CHILDREN OF ORDINARY ELEMENTARY AND SPECIAL (M.D.) SCHOOLS.

It would be of great practical value if the distribution of educational ability could be compared with that of other capacities. A comparison with the distribution of some simple physical characteristic, such as height or weight, for example, would render our conception of mental variation much more concrete. Unfortunately, no satisfactory measure of variation is available. The "coefficient of variation," formed by expressing the standard deviation as a ratio of the average, is plainly dependent upon the arbitrary position of the zero from which the latter is measured. A comparable unit may perhaps be found in the average annual increment during the steadiest period of growth. In educational abilities, as we have seen, the range of educational years over which the individuals of the same chronological year vary is of considerable importance. It is of interest to observe whether the range is similar for physical characteristics.

With this object height and weight were chosen as the two physical characteristics most readily accessible for investigation. The population measured must plainly be as far as possible the same as that investigated for educational variability. It is seldom impossible to collect measurements for an entire borough. Accordingly, the following method of sampling has been devised.

Children attending schools representative of different social levels are first ranked roughly for the characteristic to be measured, and the medians then measured exactly. (This rapid method of estimating averages by a few measurements is a procedure which might well be employed with great economy of time and labour in rough surveys.) Other schools and individuals in the schools are then chosen by an artificial method of random sampling. These preliminary measurements are confined to early, middle, and late ages. Finally, measurements are obtained for entire age-groups in schools which are found to represent the extremes and medians of the entire borough. The figures for these last groups are adjusted by the aid of the preliminary measurements so as to obtain measures representative of the whole population. Values so far obtained are given below (Tables XXX. and XXXI.). Those for height are expressed in centimetres; those for weight in kilograms.

The figures for each age-group are derived from only 100–150 measurements for "normals" and 30–50 for defectives. But in virtue of the mode of selecting the individuals and the subsequent weighting of the values thus furnished, the figures are probably comparable with those obtained for the educational survey of the borough as a whole. The figures are but approximations. But the corrections to be applied were small; and indeed were kept down to their lowest limits. If anything, therefore, the variability is somewhat underestimated. Measurements for the whole County would yield slightly higher averages, and somewhat larger standard deviations.

It will be seen that for both height and weight the variability, when expressed in terms of the original units of measurement ("standard deviation"), increases with some regularity from year to year. Expressed as a percentage of the average for each age ("coefficient of variation") it remains more steady. For height it is nearly $\frac{1}{20}$ of the age-average; and for weight about $\frac{1}{10}$—at any rate about the middle of the school career. About the age of 10, the standard deviation for height, as for educational ability, is about equal to the annual increment—perhaps a little over. For

weight it is equivalent to an increase of about $1\frac{1}{4}$ years. As has generally been found, the curve of distribution for height approximates to the normal about the middle of the school career. Towards its close it shows a lengthening tail of backward children; while in the earlier years it is perhaps skewed in the opposite direction. Weight shows a more irregular distribution. The main tendency is a concentration on the zero side of the median, with a lengthened tail of heavier individuals.

In height, the average amount of overlapping between adjacent age-groups is about 64·7 per cent.; about 17 per cent. fall beyond the average for the next age. In weight the overlap is about 72 per cent.; about 23 per cent. fall beyond the average for the next age. A comparison of these various features with those characterising distribution in educational ability is suggestive. Perhaps the most important analogy is that exhibited by a comparison of variability and age-increments. Thus viewed, *educational variability appears to be of much the same order as physical variability.* The figures for overlap in the former, in fact, fall somewhere between those for height and weight. We should expect it to be greater. The increased overlapping of consecutive age-groups shown by tests of higher mental capacities suggests that educational variability is slightly underestimated. With these tests the standard deviation may rise to $1\frac{1}{2}$ times the difference between the averages for successive years. But I am unable at present to give figures from comparable groups.

Special school children appear on the average to be slightly subnormal in height and weight. But the subnormality is attributable chiefly to pathological conditions obtaining in a few exceptional cases and to unfavourable social conditions obtaining in more numerous cases. It is by no means a universal characteristic.

Current comparisons of the physical development of defectives with that of normals are commonly vitiated by the fact that the two sets of measurements are often obtained from widely separated districts and from widely differing social classes. Though obtained within the same borough and from children of the elementary school class, the figures given in Tables XXX. and XXXI. are still somewhat vitiated in these respects. Among the defectives there still exists a larger proportion drawn from poorer streets, from more crowded homes, and from more degenerate families.

On an average the defectives appear retarded in height by about two-thirds of a year (boys) to three-quarters of a year (girls) and in weight by about one-quarter (boys) to one-third of a year (girls). The averages, however, are somewhat deceptive. In most cases the number of defectives who reach or exceed the normal average is nearly 45 per cent. The overlap, therefore, does not fall greatly short of 95 per cent. The averages are pulled down partly by an absence of moderately (as distinct from disproportionately) tall individuals, but chiefly by an asymmetrical tail of stunted individuals. Among the defective girls overgrown and overheavy individuals often swell the averages for higher years. On the average, the defectives appear to deviate from the normal average by rather over one-half the normal standard deviation for height, and by rather under one-half for weight. Defectives vary about these averages far more than normals, especially in height. The average co-efficients of variation are, for height: normals, 4·6; defectives, 5·1; for weight: normals, 12·3; defectives, 12·8. The defective groups are too small to yield figures for publication at each age. And throughout the data hitherto collected are sufficient for rough comparisons only.

For other physical characteristics my records are at present too limited to give any sure results. Chiefly I have noted the presence, absence, number and degree of so-called stigmata. Among anatomical measurements those showing the clearest differences are measurements of the head. Compared with normals special school children as a group show a slight subnormality in size; and a distinct increase in variability. Other stigmata are undoubtedly common in special schools. But my results indicate that they are also much commoner in ordinary schools than is usually believed. Control enquiries into the frequency and numbers of stigmata in normal children are urgently needed. Their increased frequency among special school children could largely be accounted for, were the stigmata themselves used as a practical guide in deciding the admissions. The special clinical varieties of amentia—mongolian, cretinoid, hydrocephalic, microcephalic, rachitic, and other types—exhibit so-called stigmata in marked numbers. But with the doubtful exception of those associated with rickets or microcephaly, these types are comparatively rare in the cases to be recommended for special schools by the teachers of the ordinary school. Constitutional and physical defects—such as subnormal vision, subnormal hearing, obstruction of nose or throat, retarded or disproportionate development, speech defects, motor defects, pretubercular and rheumatoid conditions—these are much commoner. *But many serious cases of backwardness exhibit no obvious physical signs or stigmata whatever.* To those not medically qualified, therefore, physical indications may be most misleading. Many teachers are still apt to give too much attention to anomalies of the harder structures of the head and face—asymmetrical, misshapen, and small skulls, low, narrow and bossed foreheads, broad, depressed, and upturned noses, narrow, high, and **V**-shaped palates, and lobeless, projecting, and malformed ears. Face provides more signs than skull. But, if the child's physiognomy is to be trusted at all, notice should be paid not so much to peculiarities of bone or gristle, but rather to the soft and especially to the muscular structures; and not shape or structure as such, but to expression and response. The value, however, of such signs depends enormously upon the experience and personal power of observation of the individual teacher.

In physiological as distinct from anatomical measurements—in dynamometric measurements of muscular power, in spirometric measurements of lung capacity, for example—defectives on an average show a subnormality that is more clearly marked. Here, limitations in regard to apparatus have prevented extended enquiries; I have, however, to acknowledge generous assistance from the psychological laboratories of King's College and of University College. But, limited as my experiments have been, they leave no doubt that even in physiological measurements the subnormality by no means approaches that revealed by tests of intelligence and of specific psychological capacities; much less does it approximate to that displayed in educational ability. It seems clear, therefore, that *a diagnosis of educational backwardness should be based primarily upon the child's educational performances with standardised educational tests.*

The foregoing investigations I hope to repeat on a larger scale. If corroborated, the results would suggest that the diagnosis of special school cases may constitute, in the first instance, an educational and a psychological problem rather than a medical one. Expert physical and medical examinations are indispensable. But they are needed rather to throw light upon the possible physical causes, and upon the possible need for that special hygienic and medical treatment which is often an essential pre-requisite to the success of the special teaching in the special school.

TABLE XXX.—HEIGHT.

(Average and variability at each age.)

Age.	Boys.				Girls.			
	"Defectives."	"Normals."			"Defectives."	"Normals."		
	Average.	Average.	Standard Deviation.	Coefficient of Variation.	Average.	Average.	Standard Deviation.	Coefficient of Variation.
4—	—	97·9	4·0	4·1	—	96·9	4·2	4·3
5—	—	102·6	4·0	3·9	—	102·2	3·8	3·7
6—	—	106·7	4·5	4·2	—	106·0	4·4	4·2
7—	—	114·5	4·2	3·7	—	114·1	4·7	4·1
8—	116·1	119·4	5·1	4·3	116·8	119·0	5·0	4·2
9—	122·8	124·5	5·4	4·3	119·5	123·7	5·1	4·1
10—	125·3	129·3	5·0	3·9	126·4	128·9	5·6	4·3
11—	132·3	133·6	5·9	4·4	127·6	134·2	6·8	5·1
12—	134·9	138·1	6·2	4·5	137·7	139·9	7·2	5·1
13—	142·6	143·3	6·9	4·8	141·9	146·2	7·9	5·4
14—	144·4	148·9	7·5	5·0	145·9	152·0	7·1	4·7

TABLE XXXI.—WEIGHT.

(Average and variability at each age.)

Age.	Boys.				Girls.			
	"Defectives."	"Normals."			"Defectives."	"Normals."		
	Average.	Average.	Standard Deviation.	Coefficient of Variation.	Average.	Average.	Standard Deviation.	Coefficient of Variation.
4—	—	16·3	1·4	8·6	—	15·7	1·3	8·3
5—	—	17·7	1·6	9·0	—	17·3	1·8	10·4
6—	—	19·5	2·1	10·8	—	19·1	2·0	10·5
7—	—	21·5	2·2	10·2	—	20·9	2·1	10·1
8—	22·4	23·2	2·3	10·0	21·4	22·9	2·3	10·0
9—	24·9	25·4	2·8	11·0	23·7	25·0	2·7	10·8
10—	26·9	27·6	2·9	10·5	26·8	27·1	3·1	11·5
11—	29·8	29·8	3·5	11·7	27·6	29·8	4·1	13·8
12—	30·7	32·4	4·3	13·3	32·1	33·1	4·7	14·2
13—	33·4	35·8	4·7	13·1	35·7	37·2	5·6	15·1
14—	36·3	38·4	5·5	14·3	39·7	41·1	5·1	12·4

APPENDIX II.

IDEAL CLASSIFICATION OF CHILDREN ACCORDING TO EDUCATIONAL ABILITY AT EACH AGE.

On the basis of the data obtained in the foregoing Memoranda I have endeavoured to reconstruct a table showing the most probable distribution of children according to educational ability at each age (Table XXXII.). This table may be taken as a first approximation to a model scheme of school classification. The following hypotheses are assumed. First, educational ability is treated as distributed normally within each age. Secondly, the average amount of progress is treated as the same from year to year.

For purposes of calculation the equations assumed are as follows—

Class at each age = (·95 × age − 5·75) standards.

Standard deviation at each age = ·11 × (age − 0·5) standards.

The average class and the average variation in class thus determined are given for each age in the last two columns (unbracketed figures).

The equations are derived from the observed data obtained in the educational survey of the borough (pp. 24 and 31 above). In view of certain inferences from the distributions found in physical characters and tested abilities, the original equations have been slightly modified and reduced to convenient fractions. The observed averages and standard deviations, corrected for fluctuations in numbers at each age, are given in the last two columns in brackets.

The meaning of the first equation may be roughly expressed as follows. On an average children born on 31st January are assumed to be at birth $6\frac{3}{4}$ standards below the line which at that period of the school year separates grade iii. and standard I. On an average they progress by nineteen-twentieths of a standard in each succeeding year. They will thus pass the grade ii.–iii. line on their fifth birthday, and the centre line of standard Ex.-VII. on their 15th birthday. At age 7 (just before promotion from the infants' department) they will be one-tenth of a class from the standard 0–I. line; and at age $10\frac{1}{2}$ (on 31st July, at average scholarship age) just over $\frac{3}{4}$ of a class below the standard IV.–V. line, the lines throughout referring to the level separating successive standards on 31st January.

The second equation may be given the following interpretation. Measured in standards, the average—or, rather, the two-third—range of the individuals of a given age-group (in technical terms, the "root-mean-square deviation" about their average class) is taken as 11 per cent. of their age in years last birthday. This figure is the value observed for ages 5 and 10 (see table X.). At other ages the values are somewhat lower relatively; but there are obvious reasons why at these ages teachers should have differentiated less, while it is unlikely that they should anywhere exaggerate the differences.

In each age-and-class sub-group, the percentages, both calculated and observed, have been first adjusted for fluctuations in age. For each age, the totals assigned in the table (last column but two) are proportional to the figures reported for the whole of the county.[1] The middle age of senior departments (age 10) has been taken as the standard for comparison: and its number put at 100·0. To this base the numbers in the other ages have been reduced in proportion. The ratios obtained have been used as a set of index numbers for weighting the percentages throughout the several age-groups. As applied to a typical senior department accommodating 350 children, the adjusted percentages may be divided by 2. This brings them to the familiar base of about 50 children per age. Owing to this adjustment, the observed totals, averages, and particularly the standard deviations for each class, differ from the values to be found from Tables IX. and X.

The lines demarcating cases for special (M.D.) and for central schools respectively are generalised from what appears to be the actual practice of those controlling the admissions.

(1) *Annual Report of the Council, 1913*, Chap. XXXVIII, page ix., Appendix V. Table showing total number of children on roll of elementary schools, excluding special schools, but including central and higher grade schools, on 31st January, 1914, grouped according to ages as at that date

TABLE XXXII.—IDEAL AGE

Theoretical distribution of children

Table showing the proportion of children in each age-

Figures bracketed in small type show actual assignments and averages; data from Table IX., are suitable for recommendation for a special (M.D.) school. Where the line completely Cases above the dotted line to the right are suitable for central or other higher grade weighting the figures for each class or age by the number in each.

Age.	Below Grade i.	Grade i.	Grade ii.	Grade iii.	St. I.	St. II.	St. III.	St. IV.
3–	9·2 (0·0)	1·0 (10·2)	—	—	—	—	—	—
4–	4·8 (0·0)	30·0 (34·9)	5·5 (5·4)	—	—	—	—	—
5	0·4 (0·0)	19·3 (16·8)	63·0 (68·8)	16·6 (13·9)	0·2 (0·0)	—	—	—
6–	—	1·7 (0·8)	26·3 (20·8)	57·6 (69·8)	19·5 (14·1)	1·0 (0·6)	—	—
7–	—	0·1 (0·0)	3·9 (1·3)	29·0 (25·5)	49·7 (64·2)	20·0 (12·9)	1·8 (0·6)	—
8–	—	—	0·4 (0·1)	6·4 (2·5)	29·6 (31·9)	42·4 (47·9)	19 5 (16·6)	2·8 (2·2)
9–	—	—	0·1 (0·0)	1·0 (0·4)	9·0 (8·8)	29·5 (28·5)	37·7 (42·2)	19·3 (17·5)
10–	—	—	—	0·2 (0·2)	2·0 (2·1)	11·2 (10·9)	28·7 (29·0)	33·7 (34·3)
11–	—	—	—	—	0·5 (0·5)	3·1 (2·6)	12·5 (12·9)	27·0 (28·2)
12–	—	—	—	—	0·1 (0·1)	0·7 (0·7)	4·2 (4·0)	13·2 (14·0)
13–	—	—	—	—	0·1 (0·0)	0·2 (0·3)	1·2 (1·7)	5·1 (7·0)
14–	—	—	—	—	—	—	—	0·2 (0·1)
15–	—	—	—	—	—	—	—	—
Total in each class	14·4	52·1 (62·7)	99·2 (96·4)	110·8 (112·3)	110·7 (121·7)	108·1 (104·4)	105·6 (107·0)	101·3 (103·3)
Average age for each class	3·89	4·92 (4·63)	5·80 (5·69)	6·76 (6·67)	7·83 (7·86)	8·90 (8·96)	9·95 (10·02)	10·93 (11·04)
Standard deviation for each class. (Variation in age.)	0·46	0·53 (0·62)	0·59 (0·46)	0·77 (0·63)	0·93 (0·84)	1·00 (0·97)	1·08 (1·08)	1·14 (1·15)

AND STANDARD SCHEME.

according to age and ability.

group assignable to the grade or standard indicated.

corrected for fluctuations in size of age-groups. Cases below the dotted zig-zag line to the left encloses a group, only those in the lower portion of the class are suitable for recommendation. schools. Figures marked [*a*] are grand averages for the whole group, *i.e.*, averages obtained by

St. V.	St. VI.	St. VII.	St. Ex. VII.	Above St. Ex. VII.	Total for each age.	Average class for each age.	Standard deviation for each age.
					Percentage of children aged 10.	Grade.	Classes.
—	—	—	—	—	10·2 (10·2)	0·57 (1·50)	0·33 (0·06)
—	—	—	—	—	40·3 (40·3)	1·52 (1·64)	0·44 (0·34)
—	—	—	—	—	99·5 (99·5)	2·47 (2·47)	0·55 (0·55)
—	—	—	—	—	106·1 (106·1)	3·42 (3·45)	0·66 (0·62)
						Standard.	
—	—	—	—	—	104·5 (104·5)	1·37 (1·37)	0·77 (0·63)
0·1 (0·0)	—	—	—	—	101·2 (101·2)	2·32 (2·34)	0·88 (0·75)
3·8 (3·0)	0·3 (0·2)	0·0 (0·1)	—	—	100·7 (100·7)	3·27 (3·27)	0·99 (0·91)
18·9 (18·2)	4·7 (4·7)	0·6 (0·6)	—	—	100·0 (100·0)	4·22 (4·22)	1·10 (1·10)
29·9 (29·8)	17·8 (17·2)	5·4 (6·0)	0·9 (0·0)	0·1 (0·0)	97·2 (97·2)	5·17 (5·14)	1·21 (1·17)
24·5 (25·4)	26·1 (27·6)	16·0 (18·4)	5·8 (1·8)	1·4 (0·0)	92·0 (92·0)	6·12 (6·00)	1·32 (1·18)
13·5 (12·9)	22·4 (22·2)	23·2 (33·4)	15·0 (8·7)	7·9 (2·4)	88·6 (88·6)	7·07 (6·78)	1·43 (1·24)
0·6 (0·3)	1·3 (0·5)	2·0 (2·1)	2·0 (3·4)	2·2 (1·9)	8·3 (8·3)	8·02 (8·20)	1·54 (1·10)
—	0·1 (0·0)	0.2 (0·1)	0·3 (0·3)	0·5 (0·7)	1·1 (1·1)	8·97 (9·11)	1·65 (0·57)
91·3 (89·6)	72·7 (72·4)	47·4 (60·7)	24·0 (14·2)	12·1 (5·0)	949·7 (949·7)	2·95 [*a*] (2·93) [*a*]	0·95 [*a*] (0·86) [*a*]
11·79 (11·81)	12·46 (12·44)	12·95 (13·00)	13·29 (13·65)	13·63 (14·16)	9·17 [*a*] (9·17) [*a*]	— —	Years. Years.
1·07 (1·02)	0·92 (0·88)	0·76 (0·74)	0·63 (0·46)	0·63 (0·65)	0·88 [*a*] (0·87) [*a*]	— —	Years. Years.

The table is presented as a summary embodiment of tentative suggestions, not as a standard pattern for exact imitation. Whether theoretical or actual, the distribution of ability is by no means the sole consideration in organising a department into classes. Practical exigencies must be considered first. The number and size of classrooms, the qualifications of the staff, the special character of the locality, the intellectual and moral peculiarities of individual pupils—these may outweigh theoretical motives. Yet, in the background, there may well be an exactly formulated plan. To teachers the observed distribution will be of more interest than the theoretical. Based as it was in part upon teachers' actual classifications and estimates, influenced as it manifestly is by actual regulations for promotion, the observed distribution doubtless reflects the general arrangement followed by their colleagues as a whole. A few may be interested to note the divergencies of the observed arrangement from the theoretical, and weigh the issues which these divergencies raise.

The average features of the distribution remain much the same in the case of both the observed and the theoretical schemes.

The sizes of the classes are but little altered. In practice too many children appear to remain at the level of standard I., and again perhaps at that of standard III. This is perhaps due in part to the conditions of promotion from infants' and junior mixed departments; perhaps also to the frequency of dividing standard III., among two classes. There seems a similar accumulation in standard VII., perhaps due in part to an analagous overlap between ordinary and central schools.

The average class for each age is, by hypothesis, unaltered, except that the gradation has first been smoothed. The slight levelling up of ages 12– and 13– raises the average class of the entire group a fraction nearer the standard II-III. line.

The average age for each class is but little changed. In both schemes the age difference between consecutive classes is approximately one year up to standards IV. to V.; but at this point it begins to decrease much more rapidly.

For all ages except five and ten, the variation in class is, by hypothesis, increased, especially in later years. Owing to the gradual increase in the standard deviations of each age-group, the correlation is not "normal." Hence, if ability is assumed to be distributed normally within each age, then *age should not be normally distributed within each class.* Its distribution will be more or less asymmetrical. In the lower classes there will be a tail prolonged into the higher ages by the presence of children from the older age-groups. In the higher classes the opposite tail will be prolonged by the presence of children from the middle age-groups. (Cf., for example, standards I. and VI.)

The variation in age is slightly increased in eight out of the thirteen classes. But the change is no greater than that produced by the slight readjustments of the relative proportions of the totals at each age. (Cf. Table X., last column, standard deviations in years, with average observed standard deviations in Table XXXII., last line.) The change in age variations is most conspicuous in standard I. This class now covers a range of nine years. The children of the three highest ages, however, should be accommodated in a special class or school. Standards IV. and V., therefore, remain the most heterogeneous in age. The oldest at this level are not backward enough for a special school; the youngest are too young for a central school. To avoid the difficulties of mixing children of eight with those of fourteen it would be desirable to duplicate one—preferably the lower—of these standards. If, therefore, there is provision for an extra class, and there is no urgent need for it elsewhere, this seems the most advantageous point. In considering the age-range of the classes it should be remembered that the figures primarily represent the distribution, not in a single department, but in a whole borough. In a school drawing from a population of about the same social class, the variation will doubtless be smaller. As a rule the range will not extend to figures under 2·0, since fractions of a child are impossible, and 2·0 per cent. represents 1 child in an age-group of 50. Hence the 7-year range of standard V., for example, means that 8-year old children will probably be found in the same class for ability as children of 14, not in the same school, but only in a child population so large as to include a thousand individuals in each of the middle age-groups.

A detailed comparison of observed and calculated figures in the age-and-class sub-groups shows greater differences than in the average. These differences, too, are of greater practical interest.

In the first place, except for ages 10 and 11, there is a general reduction in the number of children whose age directly corresponds to class on the "one-year one-class" hypothesis. As a rule the numbers are made up not so much by the inclusion of very young or very old children, but usually by a slight increase in the number, already large, of children only one year above or below the present age. For example, the calculated table shows a 30 per cent. increase in the numbers of children aged 6– in standard I., and of children aged 7– in standard II. An increase in the assignment of backward children aged 6– to grade II., and aged 7– to grade III. is indicated to a less extent. More children aged 8– are credited with the abilities of standards III. and IV., and possibly more aged 9– with those of standards IV. and V. At ages 10– and 11–, the children, as shown by the observed figures, seemed to have found their ideal levels; or it may be they have been long enough in the senior department for teachers to have discovered their capacity or incapacity. At the ages of 12– and 13– a greater proportion is theoretically assigned to levels above standard VII. But the inclusion of children and estimates from central schools, and the exclusion of children holding scholarships at secondary schools, make the figures here somewhat uncertain.

It is interesting to observe how far the distribution of children in their school classes corresponds with their distribution according to ability or attainments. For this we must take an age-group in the middle of the school organisation, for example, age 10. Every teacher in the borough has been good enough to classify the children of this age both according to the standards in which they are working, and according to educational ability estimated in grades and standards. The results show that the average range over which the children vary is distinctly wider for estimated ability than for actual class. The standard deviations are: (A) Boys: (1) Class, 1·06; (2) Ability, 1·15. (B) Girls: (1) Class, 0·94; (2) Ability, 1·12. The sex difference is suggestive. In girls' departments children of the same age are less scattered over different school classes.

Thus obtained, however, estimates of ability are necessarily rough. Probably they still understate the degree of natural variability. To surmount this inexactitude there is but one procedure: to examine all the children by the same scheme of tests. Many teachers have already commenced to carry out scientific studies of their examination results. Perhaps, in the near future, some of the more enterprising may, for their own interests and enlightenment, voluntarily organise among themselves an experimental examination by comparable tests. A joint terminal examination, where various schools agree to use the same set of questions, might, for example, be arranged. For the chief subjects of the school curriculum we should thus obtain, not merely "norms" for every age, but, what is far more valuable, a picture of the distribution of ability in each age-group, showing the range or limits of normal variation. This no psychologist has yet obtained. Such a scheme demands a volunteer enquiry undertaken not by theoretical psychologists but by practical teachers, working in co-operation, perhaps with a psychologist, but certainly with each other. Only in this way can results of permanent value be achieved.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